BOEING 707-138

MAINTENANCE MANUAL

CHAPTER 80

STARTING

TABLE OF CONTENTS

Subject	Subject No.	Page No.
STARTING SYSTEM	. 80-1-1 . 80-1-1 . 80-1-3 . 80-1-4	201 201 201 201 201
STARTER AIR BOTTLE PRESSURE INDICATING SYSTEM	. 80-5-0	

This Table of Contents lists subjects contained in the Qantas 707-138 Maintenance Manual. Where these subjects conflict with those contained in Boeing 707 Stratoliner Maintenance Manual (Document D6-4004), the Company Manual will take precedence. Holders of Manuals when in receipt of Qantas Maintenance Manual revisions must revise the Table of Contents contained in the applicable chapter of both the Manuals.



CHAPTER 80

STARTING

TABLE OF CONTENTS

Subject	Subject No.
STARTING SYSTEM	80-1-0
High/Low Pressure Air Starter	80-3-2
Starter Low Pressure Air Shutoff Valve	80-2-21



CHAPTER 80

STARTING

ALPHABETICAL INDEX

Subject	Subject No.	Page No.
HIGH/LOW PRESSURE AIR STARTER Description	80-1-0 80-3-2 80-3-2	5 201 202
STARTER LOW PRESSURE AIR SHUTOFF VALVE Description	80-1-0 80-2-21	7 201
STARTING SYSTEM Description	80-1-0 80-1-0 80-1-0 80-1-0	1 7 101 201 202



MAINTENANCE MANUAL

Subject	Subject No.	Page No.
(see Combustion-Pneumatic Starter) (see High Pressure Air Starter) (see Low Pressure Air Starter) (see Pneumatic Starter)		
Description	80-0 80-3-21 80-3-21	17 201 201
STARTER AIR BOTTLE Description	80-1-0 80-3-22 80-3-22	11 201 201
STARTER AIR BOTTLE ELECTRICAL PRESSURE-INDICATING SYSTEM Description	80-5-0	1
STARTER AIR BOTTLE GROUND CHARGING VALVE Description Description Removal/Installation	80-0 80-1-0 80-3-61	24 15 201
Description Description Removal/Installation	80-0 80-1-0 80-3-71	22 13 201
STARTER AIR BOTTLE PRESSURE GAGE Description	80-5 - 0 80-5 - 11	1 201
STARTER AIR BOTTLE PRESSURE INDICATING SYSTEM Description	80-5-0 80-5-0	1 101
STARTER AIR BOTTLE PRESSURE RELIEF VALVE Description Description Removal/Installation Removal/Installation Removal/Installation	80-0 80-1-0 80-3-51 80-3-52	29 12 201 201
STARTER AIR BOTTLE PRESSURE TRANSMITTER Removal/Installation	80-5-1	201



Subject	Subject No.	Page No.
STARTER AIR COMPRESSOR Description Description Operation Operation Removal/Installation	80-0 80-1-0 80-0 80-1-0 80-4-1	18 16 21 17 201
STARTER AIR COMPRESSOR CHECK VALVE Removal/Installation	80-4-41	201
STARTER AIR COMPRESSOR PRIORITY VALVE (Airplanes VH-EBH an Description	d on) 80-1-0	20
STARTER AIR COMPRESSOR SOLENOID VALVE Description Description Removal/Installation	80-0 80-1-0 80-4-31	29 18 201
STARTER LOW PRESSURE AIR SHUTOFF VALVE Description Description Removal/Installation Removal/Installation	80-0 80-1-0 80-2-11 80-2-21	25 10 201 201
STARTING SYSTEM Description	80-0 80-0 80-0 80-0	1 29 201 202
STARTING SYSTEM Description	80-1-0 80-1-0 80-1-0 80-1-0	1 2 2 201 202

TRANSMITTER

(see Starter Air Bottle Pressure Transmitter)



Subject No. Fage No.

VALVE (see Auxiliary Starter Air Bottle Solenoid Valve) (see Bottle Discharge Pressure Regulating and Shutoff Valve) (see Combustor Air Fressure Relief Valve) (see High Pressure Air Relief Valve) (see Starter Air Bottle Ground Charging Valve) (see Starter Air Bottle Isolation Valve) (see Starter Air Bottle Pressure Relief Valve) (see Starter Air Compressor Check Valve) (see Starter Air Compressor Priority Valve) (see Starter Air Compressor Solenoid Valve) (see Starter Low Pressure Air Shutoff Valve)

STARTING
Starting System
Description and Operation



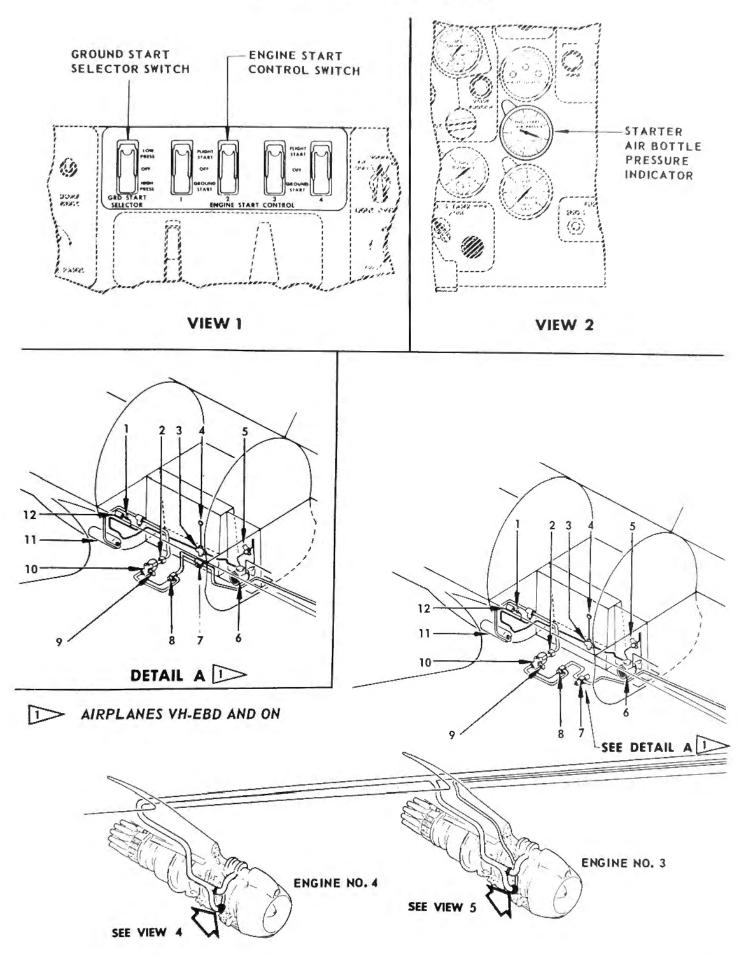
STARTING SYSTEM - DESCRIPTION AND OPERATION

1. General

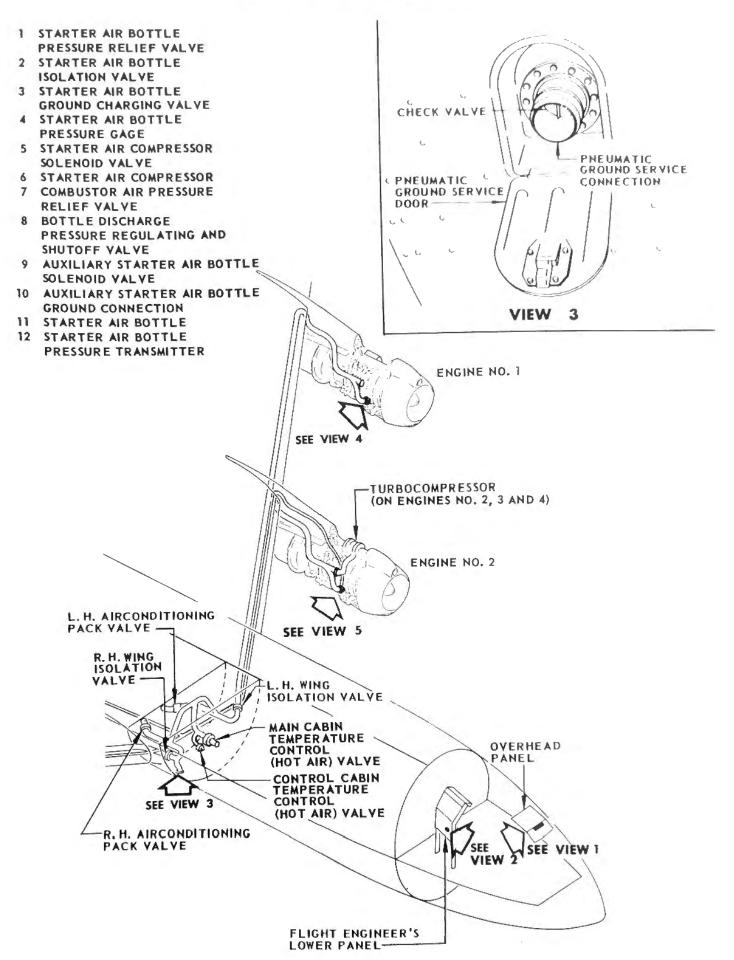
- A. The starting system provides a means of rotating the N₂ engine compressor to an rpm range at which an engine start may be accomplished when fuel and ignition are supplied. The airplanes are equipped with pneumatic starters on engines No. 1 and 4, and with combustion-pneumatic starters on the inboard engines (No. 2 and 3). The pneumatic starters may be driven by low pressure air supplied from either an airplane self-contained source or from an external source. The combustion-pneumatic starters may be operated by low pressure air or by high pressure exhaust gases from a starter-mounted combustor. Each of the starters is geared to the N₂ engine compressor through an accessory drive gear case.
- B. The major components of the starting system are: two pneumatic starters, two combustion-pneumatic starters, one starter air bottle and a starter air compressor. (See figure 1.) Other components comprising the starting system include: a low pressure pneumatic ground service connection and manifold, a high pressure air ground connection, valves which regulate and control the distribution of the low and high pressure air used to operate the starters, and associated tubing which connects the high pressure air supply, starter air compressor, and the combustion-pneumatic starters.
- C. All starters may be driven by low pressure air from the pneumatic manifold. Low pressure air is supplied to the pneumatic manifold from a low pressure air ground service cart or an operating turbocompressor on engines No. 2, 3 or 4. The cart connects to the manifold through an external pneumatic ground service connection on the right side of the fuselage forward of the wing. (See view 3, figure 1.) Refer to "Pneumatic System", Chapter 36 for information on the turbocompressors and the pneumatic manifold. In addition, the combustion-pneumatic starters may be operated by high pressure exhaust gases from a combustor. The combustor is supplied high pressure air from a starter air bottle. The selection of either low pressure air or combustor starts is optional and dependent upon the availability of supply at the time of a starting operation.



STARTING
Starting System
Description and Operation

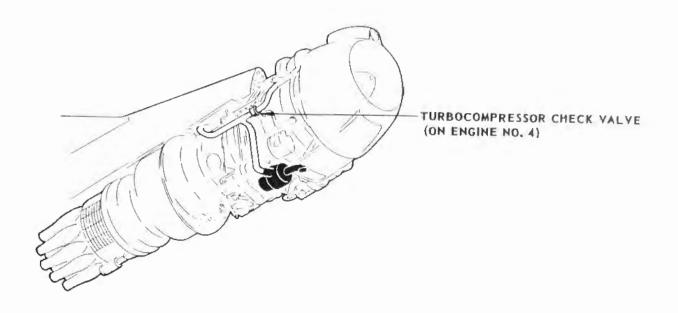


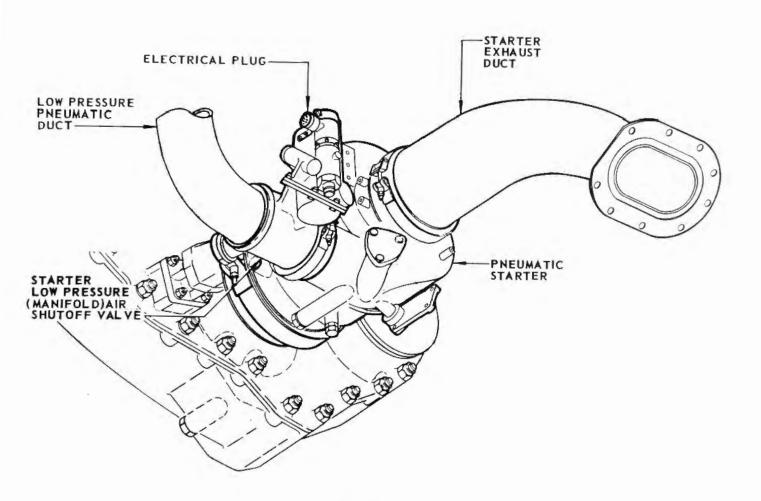
Stratoliner MAINTENANCE MANUAL





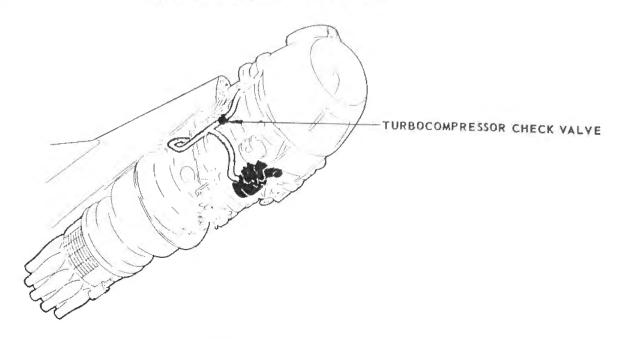
STARTING
Starting System
Description and Operation

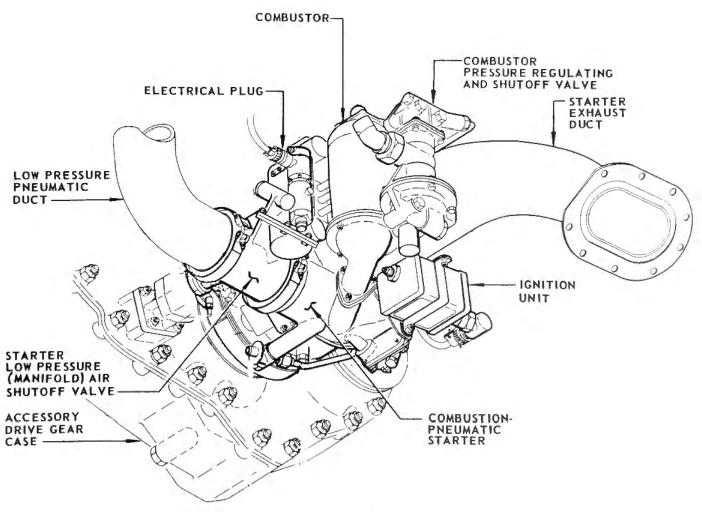




VIEW 4 PNEUMATIC STARTER

Starting System Equipment Location Figure 1 (Sheet 3 of 4)





VIEW 5 COMBUSTION PNEUMATIC STARTER



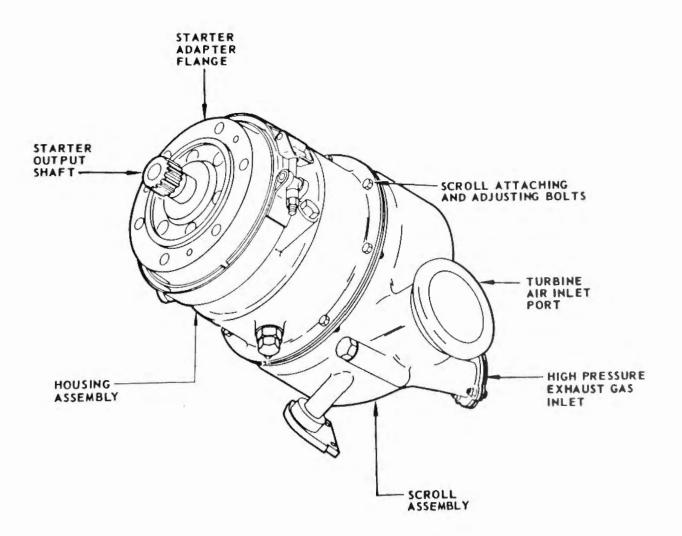
2. Pneumatic Starter

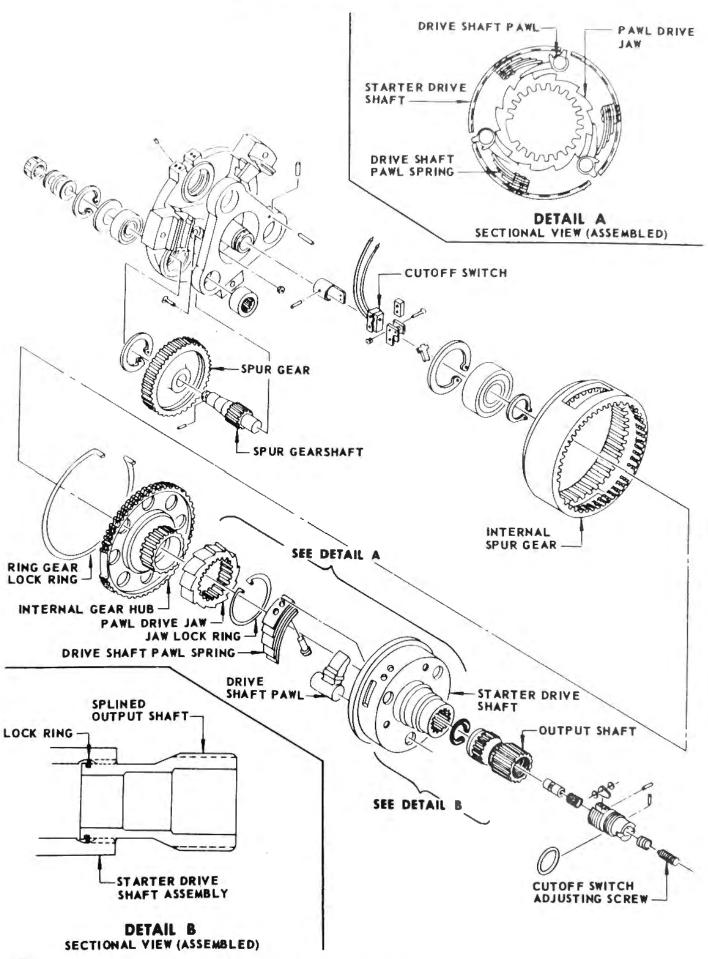
A. General

(1) The pneumatic starter (figure 2) is an air motor which converts the energy of compressed air into rotative mechanical force sufficient to accelerate the engine to starting speed. Low pressure air and electrical energy are required for starter operation. The starter accelerates the engine to starting speed and continues to assist the engine after light-off until the starter cutoff speed is attained. The starter is a lightweight, turbine-type air motor and consists of a turbine wheel assembly, a reduction gear assembly, a splined output shaft, an overrunning pawl and pawl drive engagement mechanism, and a cutoff switch mechanism, all contained within scroll and housing assemblies.

B. Reduction Gear Assembly

(1) A reduction gear assembly contains an output shaft which serves as a shear section and is replaceable without disassembling the starter. (See figure 3.) The ratio of starter turbine and output shaft rpm's is 23.2 to 1; for example, the starter output shaft speed is 2300 rpm when the turbine is rotating at 53,360 rpm.







C. Engagement Mechanism

(1) The engagement mechanism is a pawl and pawl drive combination which connects the reduction gear system to the starter output shaft for engine starting. (See figure 3.)

D. Cutoff Switch Mechanism

(1) A snap-action cutoff switch contained within the starter is operated by governor flyweights. The switch actuating governor assembly is threaded into, and rotates with, the drive shaft. As the starter approaches overspeed, the governor flyweights extend by centrifugal force and close the normally open snap-action switch. The cutoff switch is set to close between 2300 and 2500 rpm output shaft speed or 3300 rpm minimum N2 compressor speed (34% N2 rpm). The closed cutoff switch energizes the start relay which in turn causes the starter manifold air shutoff valve to close and shut down the starter.

E. Scroll Assembly

(1) The scroll assembly encloses the turbine wheel portion of the rotating assembly, provides air inlet and exhaust connections, and incorporates self-contained turbine nozzle vanes. The scroll assembly is secured to a housing assembly by a friction clamp. A heat barrier is installed between the flanges of the scroll assembly and the housing assembly. Shims placed between the heat barrier and the flange of the housing assembly provide a means for obtaining the correct clearance between the front face of the turbine wheel and the interior of the scroll assembly. The scroll assembly may be rotated about the axis of the starter to any position required to align the air inlet connection with the pneumatic duct by loosening the eight attaching nuts.

3. Combustion-Pneumatic Starter

A. General

(1) The combustion-pneumatic starter (figure 4) is essentially a pneumatic starter combined with a combustor and control components necessary for operation. The unit can be used as a combustion-pneumatic starter or a pneumatic starter. When supplied with air, fuel, and electrical energy sources from the aircraft systems, the unit operates as a combustion-pneumatic starter. When the combustor and associated control components are bypassed, it is used as a pneumatic starter.



B. Pneumatic Starter Assembly

- (1) The pneumatic starter portion of the combustion-pneumatic starter is identical to the pneumatic starter described in paragraph 2. The turbine wheel assembly, however, may be driven by high pressure exhaust gases from the combustor, as well as by low pressure air from the pneumatic manifold.
- (2) The cutoff switch mechanism used in the pneumatic starter is the same as the one used in the combustion-pneumatic starter. Its operation for low pressure starts is explained under paragraph 2. When a high pressure start has been selected, the closed cutoff switch energizes the start relay which causes the fuel and air supply to the combustor to be cut off and thus terminate combustor operation and shut down the starter.

C. Combustor Unit and Control Components

(1) The combustor unit consists of the combustor, and three supporting systems (pneumatic, fuel and electrical) which are necessary for control and operation of the unit. (See figure 5.) The combustor unit and control components are mounted on the starter housing assembly.

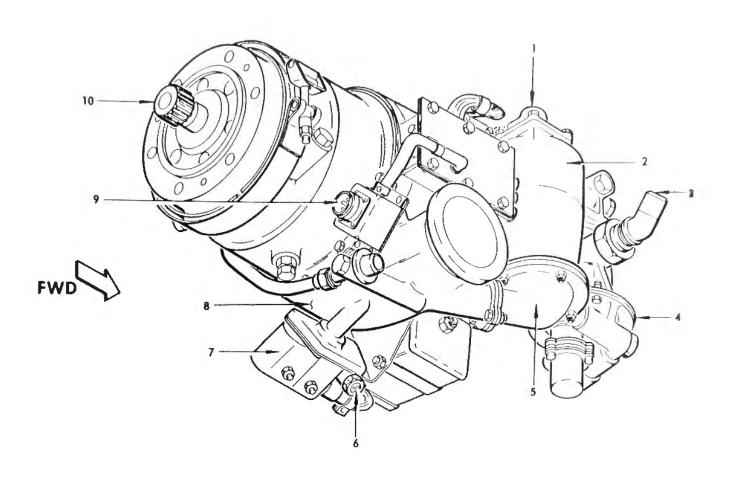
(2) Combustor

(a) Fuel and air are mixed in the combustor, and when ignited, produce the high pressure exhaust gases that are directed into the starter inlet to drive the turbine wheel. The combustor is located on the right forward end of the starter and consists of a combustor housing assembly, liner, and an elbow.

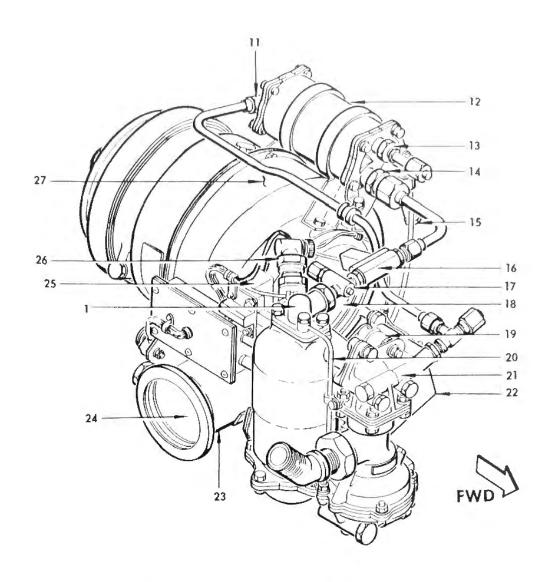
(3) Combustor Pneumatic System

(a) The combustor pneumatic system supplies the air to the combustor and the fuel accumulator. The components comprising the system are: a differential pressure regulator and air shutoff valve, an accumulator air shutoff valve, a pressure relief valve, a pneumatic sensing line from the combustor inlet to the differential pressure regulator, and associated pneumatic lines connecting to the fuel accumulator.





- INLET FUEL COMBUSTOR NOZZLE HOUSING ASSEMBLY COMBUSTOR
- INLET SUPPLY AIR (HIGH PRESSURE FOR COMBUSTOR)
- 4 REGULATOR AND SHUTOFF VALVE-DIFFERENTIAL PRESSURE
- 5 ELBOW COMBUSTOR
- 6 PLUG ACCUMULATOR AIR PURGE
- 7 SWITCH THERMOSTATIC
- 8 SCROLL ASSEMBLY-STARTER
- 9 RECEPTACLE ELECTRICAL 10 SHAFT STARTER OUTPUT



- 11 INLET ACCUMULATOR AIR
- 12 ACCUMULATOR PRESSURIZING FUEL
- 13 OUTLET ACCUMULATOR AIR PURGE
- **OUTLET ACCUMULATOR FUEL**
- 15
- VALVE FUEL INLET CHECK VALVE FUEL SHUTOFF SOLENOID VALVE FUEL REGULATING
- 17
- 18 EXHAUST STARTER TURBINE 19 VALVE AIR SHUTOFF SOLENOID
- 20 LINE PNEUMATIC SENSING

- 21 HOUSING AIR SHUTOFF SOLENOID VALVE
- 22 UNIT IGNITION
- 23 SCROLL ASSEMBLY STARTER 24 INLET TURBINE AIR SUPPLY (LOW PRESSURE)
- 25 SWITCH PRESSURE
- 26 PLUG IGNITER 27 STARTER AIR TURBINE ENGINE

MAINTENANCE MANUAL

STARTING Starting System

OPEN)



- (b) Combustor Pressure Regulator and Shutoff Valve
 - 1) The combustor pressure regulator and shutoff valve regulates the air pressure for combustion, and meters air for the pressurizing fuel accumulator. The shutoff valve (solenoid operated) opens when the starting system controls are positioned for a ground start using a high pressure air supply. The regulator contains a filter, a poppet valve, two relief valves, a regulator valve and a diaphragm assembly. The upstream end of the regulator body connects into the high pressure air supply line and the downstream end is bolted to the shutoff valve solenoid and to a bracket on the combustor. The combustor pressure regulator and shutoff valve is accessible when the engine side cowl panels are opened.
- (c) Accumulator Air Shutoff Solenoid Valve
 - 1) The accumulator air shutoff solenoid valve controls the air supply to the pressurizing fuel accumulator. The valve is installed in a line connecting the accumulator air inlet to a high pressure air supply. The accumulator air shutoff valve is solenoid operated and is actuated by electrical power when the starting system controls are positioned for a ground start using a high pressure air supply.
- (d) Accumulator Pressure Relief Valve
 - The accumulator pressure relief valve is a spring-loaded poppet valve located between the line connecting the combustor pressure regulator to the fuel accumulator and the main air supply line connecting the combustor to the combustor pressure regulator. The relief valve operates when the air supply to the fuel accumulator exceeds a preset pressure valve.
- (4) Combustor Fuel System
 - (a) The combustor fuel system, consisting of a pressurizing fuel accumulator assembly, fuel shutoff solenoid valve, fuel regulating valve, and fuel nozzle assembly, provides the required amount of fuel to the combustor.



- (b) Pressurizing Fuel Accumulator Assembly
 - 1) The pressurizing fuel accumulator assembly, located on the top left side of the starter housing, contains a spring-loaded piston and utilizes the regulated supply air from the combustor differential pressure regulator to furnish fuel under pressure to the fuel nozzle assembly. The supply air line and the accumulator drain line connect to the accumulator at the aft end. The fuel inlet, located on the outboard side of the forward end of the accumulator, is fitted with a check valve. This valve is a normally-open, spring-loaded poppet-type valve and incorporates a filter. Also connecting to the forward end of the accumulator, are the fuel outlet and the air purge lines.
 - 2) The accumulator air shutoff solenoid valve opens at the initiation of the starting operation to supply air to the accumulator. The air pressure moves a piston to discharge fuel from the accumulator to the fuel nozzles in the combustor. The accumulator air shutoff valve closes upon completion of a starting operation, and air in the air chamber of the accumulator bleeds off through an orifice in the accumulator drain line. The spring-loaded piston will return and thus allow the fuel chamber to be refilled from the aircraft fuel system. Any fuel leakage past the piston is drained from the accumulator air chamber through the fuel drain line. The function of the air purge line is to eliminate any trapped air from the fuel chamber of the accumulator.
- (c) Fuel Shutoff Solenoid Valve
 - I) The fuel shutoff solenoid valve is a conventional solenoid-operated normally-closed gate valve. The valve is installed in the fuel pressure line just downstream of the fuel accumulator.
- (d) Fuel Regulating Valve
 - 1) The fuel regulating valve is a manually adjustable needle valve. It is installed in the fuel pressure line between the fuel shutoff solenoid valve and the combustor fuel inlet port.



- (e) Fuel Nozzle Assembly
 - 1) The fuel nozzle assembly, installed inside the combustor fuel inlet, consists of a nozzle, check valve, and a screen. The nozzle is designed to supply a uniform, cone-shaped spray of atomized fuel into the combustor liner. The check valve prevents fuel leakage from the nozzle at the end of a start. The screen is a fine-mesh monel gauze tube attached to the nozzle for filtering the entering fuel.
- (5) Combustor Electrical System
 - (a) The combustor electrical system consists of three harness assemblies, ignition lead assembly, terminal board, ignition unit and igniter plug, thermostatic switch, pressure switch, and interconnecting leads and wires. The system includes connections to the air and fuel shutoff solenoid valves, starter low pressure (manifold) air shutoff valve, and the cutoff switch in the starter. Light-off failure, flame-out, or overtemperature in the combustor results in shutdown of the starter through the action of the pressure switch, or thermostatic switch.
 - (b) Harness and Ignition Lead Assemblies
 - 1) One harness assembly extends from a junction box on the aft end of the starter to the terminal board, which is mounted under a cover on the right side of the starter. A second harness assembly connects the terminal board and the thermostatic switch. The third harness assembly connects the terminal board with the other electrical components of the unit. The ignition lead assembly connects the ignition unit with the igniter plug.
 - (c) Deleted
 - (d) Ignition Unit and Igniter Plug
 - 1) The ignition unit, a sealed unit containing a transformer and storage capacitors, is used to provide high energy electric discharge to the igniter plug. The ignition unit is attached to a bracket on the bottom of the forward end of the starter housing, and is connected to the igniter plug by the ignition lead assembly. The igniter plug is a shunted surface gap spark plug installed in the combustor housing assembly adjacent to the fuel nozzle assembly and is so positioned that the high-voltage spark is emitted into the atomized fuel spray from the fuel nozzle.



(e) Thermostatic Switch

1) The thermostatic switch is a normally-open, thermostatoperated switch attached to the starter scroll with the
thermostat core assembly projecting into the chamber
through which fuel-air combustion gases enter the starter.
The enclosed switch is connected through an electrical
harness to the terminal board. If an overtemperature
condition exists (750°F or greater), the switch closes to
de-energize the unit electrical circuit.

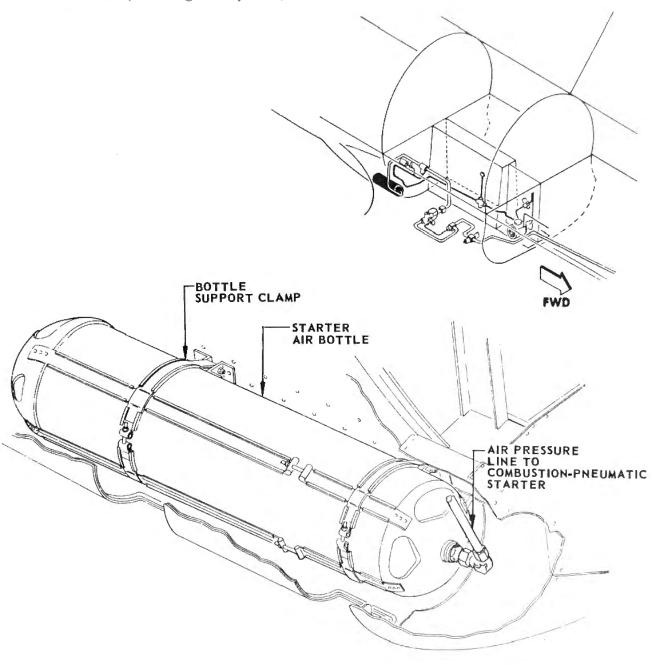
(f) Pressure Switch

1) The pressure switch consists of two normally open snapaction switches and a spring-loaded poppet installed in a switch body. The switches are closed by the poppet which is actuated by combustor pneumatic pressure. (See figure 5.) A threaded spring sleeve, installed in the switch body, provides for adjustment of the poppet spring load. The switch is attached to a support which is bolted to the lower right side of the combustor housing assembly. Under normal circumstances, combustion gas pressure in the combustor actuates the pressure switch.



4. Starter Air Bottle

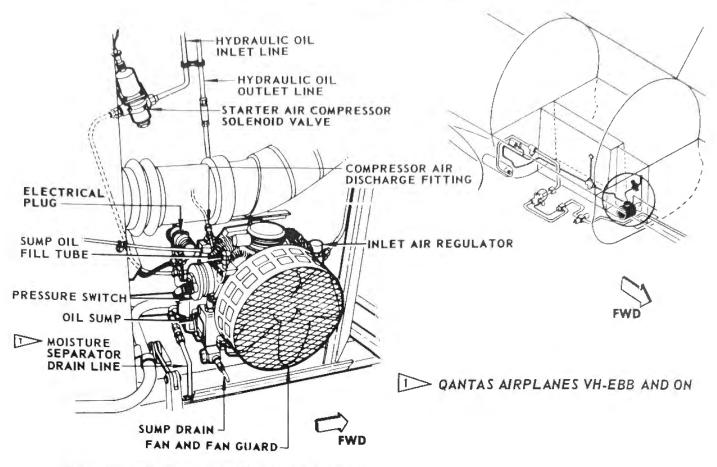
A. The starter air bottle which contains the high pressure air necessary for starter combustor operation is located in the right main landing gear wheel well aft fairing. (See figure 6.) The bottle is attached to the structure by a forward and aft strap type clamp. The starter air bottle may be charged to 3000 psig by a hydraulically driven air compressor located in the right main landing gear wheel well, or through a ground charging valve. Located on the aft end of the bottle is a condensate drain valve. A starter air bottle pressure relief valve, set to relieve at 3400 psig and to reseat at 3100 psig, is located just forward of the starter air bottle pressure transmitter in the air line. (See figure 1, 80-5-0.)



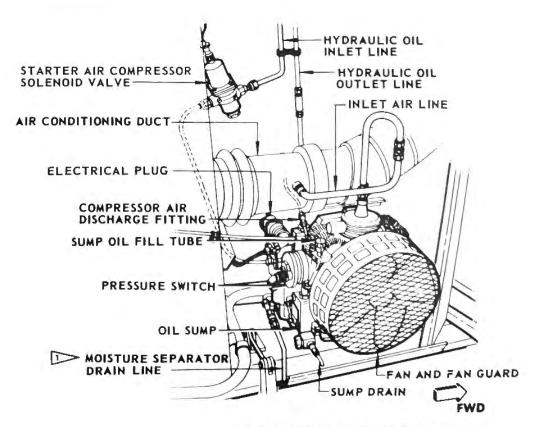


5. Starter Air Compressor

- A. The starter air compressor (figure 7), is a hydraulically driven four-stage radial compressor. The hydraulic drive motor is automatically controlled through a solenoid operated valve which in turn is electrically controlled by an air pressure switch. The compressor maintains a 2800 to 3100 psig air bottle charge for combustion-pneumatic starter operation. On QANTAS airplanes VH-EBA thru VH-EBF, air is supplied to the compressor from an air conditioning duct by a 3/8 inch line through a filter and a pressure regulator. On QANTAS airplanes VH-EBG and on, and all BNF airplanes; air is supplied from a duct by a 3/4 inch bleed line through a filter only. The starter air compressor is located in the right main landing gear wheel well forward of the water injection tank.
- B. The starter air compressor consists of the hydraulic motor, a compressor section, and several accessory items for protection and control. The compressor has an intercooler between each stage and an aftercooler. Pressure relief valves are located between compressor stages one and two and between two and three. Lubrication of the compressor is provided by an integral lube oil pump and sump. A sump oil fill line is located on top of the sump housing and extends to the top level of the compressor. An oil sump sight glass provides visual indication of lubricating oil level. (See figure 7.)
- C. On QANTAS airplanes VH-EBG and on, and on all BNF airplanes, an air filter is included on the air inlet side of the compressor. On QANTAS airplanes VH-EBA through VH-EBF an inlet air pressure regulator and inlet and suction relief valves are also fitted. On all airplanes the accessory items on the air outlet side include; a system emergency pressure relief valve, a moisture separator assembly, back pressure valve, check valve, pressure relief valve, and a pressure switch.
 - (1) Excessive moisture is extracted from the air by the moisture separator before the air enters the air bottle. The moisture separator includes a thermostatically controlled heater to prevent freezing of accumulated moisture. The moisture separator heater switch opens at 75°F and closes at 45°F.
 - (2) Incorporated in the compressor unit is the moisture separator timer which operates on 115-volt a-c power and is controlled by the pressure switch through a relay unit. The timer points are normally closed and are opened for 5 to 45 seconds every twenty minutes of compressor operation. This action causes the separator drain valve to open and and discharge accumulated moisture. With an increasing pressure the pressure switch opens at 3100 psig. The switch returns to its normally closed position when the pressure has decreased to 2800 psig. Air pressure differential between opening and closing pressures should be 200 psi minimum.



QANTAS AIRPLANES VH-EBA THRU VH-EBF



QANTAS AIRPLANES VH-EBG AND ON BNF ALL AIRPLANES

MAINTENANCE MANUAL

Starting System
Description and Operation

STARTING

Dec 15/59 Revised



- D. The starter air compressor is powered by a fixed displacement continuous service type hydraulic motor with an integral speed control. The speed is limited by a hydraulic oil control valve. On QANTAS airplanes VH-EBA through VH-EBF the compressor delivery rate is 0.40 lb/min at the rated speed at 5500 rpm. The hydraulic flow through the motor is 6.2 gpm. On QANTAS airplanes VH-EBG and on, and on all BNF airplanes, the compressor delivery rate is 0.30 lb/min at 3100 psig at a rated speed of 4200 rpm. The corresponding hydraulic flow is 4.6 gpm.
- E. Starter Air Compressor Operation
 - (1) Hydraulic power to the starter air compressor motor is controlled by a starter air compressor solenoid valve. The electrical power to the valve solenoid is controlled by an integral pressure switch on the starter air compressor to automatically control the compressor. (See figure 8.) Landing gear door lock switches also control the air compressor during landing gear operation through the compressor control relay.
 - (2) With electrical power on the starter air compressor control circuit, and hydraulic power on the utility system, the starter air compressor will run if the starter air bottle pressure is 2800 psig or lower. This level of pressure causes the air compressor integral pressure switch to close and allow 28-volt d-c power from the radio and T-R circuit breaker panel (P5) to energize the air compressor solenoid valve.
 - (3) Power from the a-c bus No. 3 circuit breaker panel (P3) provides 115-volt a-c, through the compressor control relay, to the air compressor integral timer and relay assembly to run the timer motor. The air compressor integral pressure switch also controls the relay in the timer and relay assembly. The timer unit allows the moisture separator to drain by interrupting electrical power to the compressor solenoid valve and causing compressor cut off for 5 to 45 seconds every 20 minutes.
 - (4) The compressor continues to run until air pressure in the starter air bottle reaches 3100 psig. At this pressure the integral pressure switch contacts open and disconnect 28-volt d-c power from the air compressor solenoid valve. Hydraulic power is stopped and the compressor stops running.

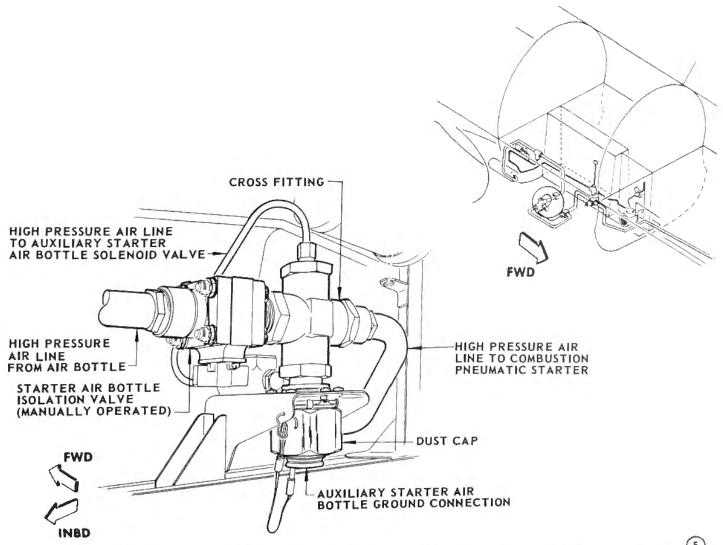


6. Starter Air Bottle Isolation Valve

A. The manually operated starter air bottle isolation valve (figure 9) is located in the wing area forward of the right main landing year strut and is installed with the cross fitting that holds the auxiliary starter air bottle ground connection. With the valve in the closed position, the starter air bottle is isolated from the system and combustor air is supplied from the auxiliary starter air bottle ground connection. In the open position, the valve incorporates the air bottle into the system. This condition allows high pressure air from a fully charged bottle to be used for combustor operation, or permits charging of the bottle through the high pressure air supply ground connection.

7. Auxiliary Starter Air Bottle Ground Connection

A. An auxiliary starter air bottle ground connection (figure 9) is provided for attaching the ground equipment which supplies the high pressure air (3000 psig) necessary for starter combustor operation. The auxiliary starter air bottle ground connection is located in the wing area forward of the right main landing gear strut. Access to the connection is gained through the right main landing gear wheel well. A cap is provided to protect the connection when it is not in use.



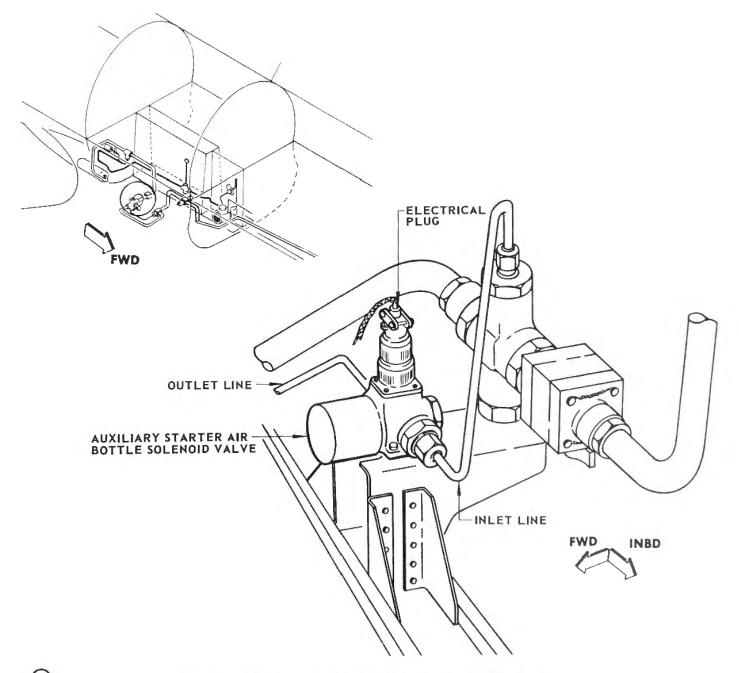
Starter Air Bottle Isolation Valve and Ground Connection Figure 9

Dec 15/59 Revised



8. Auxiliary Starter Air Bottle Solenoid Valve

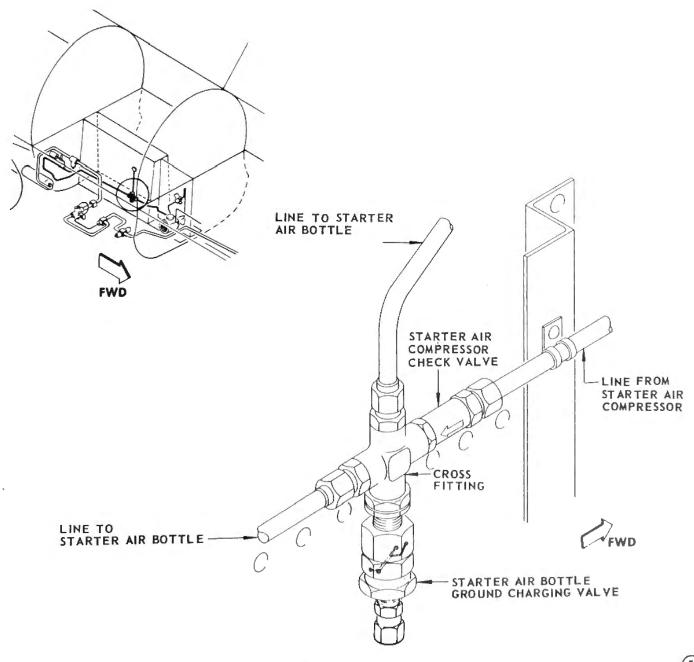
- A. The auxiliary starter air bottle solenoid valve (figure 10) is a normally open valve that is utilized to prevent damage to the high pressure air regulating and shutoff valve when an external auxiliary starter air bottle is connected. The valve is located immediately forward of the auxiliary starter air bottle ground connection, and is installed in an air line connecting the downstream side of the regulating valve piston to the high pressure line upstream of the valve. (See figure 10).
- B. When a high pressure start has been selected and the engine start switch for engine number 2 or 3 is in "GROUND START" the solenoid valve closes and allows the pressure regulating and shutoff valve to function as described in paragraph 11.





9. Starter Air Bottle Ground Charging Valve

- A. The starter air bottle ground charging valve is a standard high pressure air charging valve. It is located approximately midway in the right main landing gear wheel well on the inboard side. (See figure 11.) The charging air valve is connected in the compressor-to-bottle line through a cross fitting. The line to the pressure gage, located above the charging air valve, also connects to this fitting. (See figure 11.)
- B. The starter air bottle ground charging valve consists of a stem, O-ring seals, and a body and nut assembly. The stem is protected from thread damage and against the entry of foreign matter by a cap. The ground charging valve is opened to admit outside source air pressure by turning the 3/4 inch nut counterclockwise to a maximum of 2-1/4 turns. This unseats the valve.

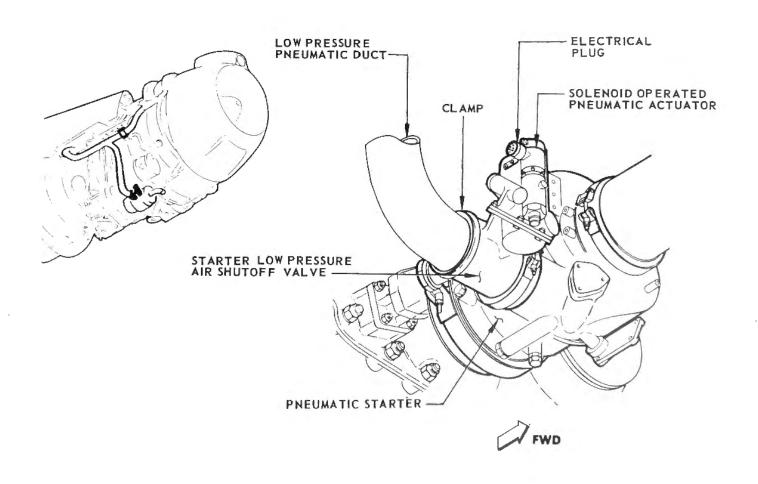


Starter Air Bottle Ground Charging Valve Figure 11



10. Starter Low Pressure Air Shutoff Valve

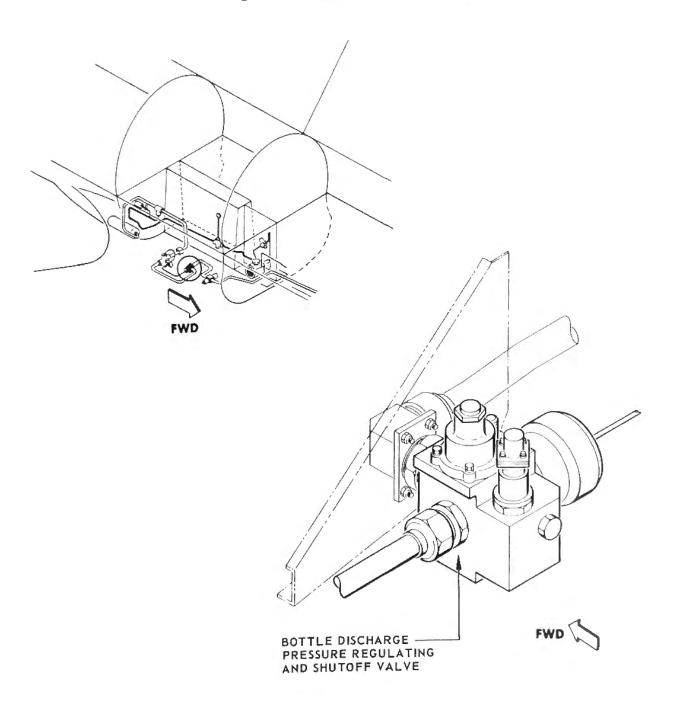
- A. The starter low pressure air shutoff valve controls the supply of air from the pneumatic duct to the starter. When a high pressure start condition is selected and the ground start selector switch is in the "HIGH PRESS" position, the starter low pressure air shutoff valve is spring loaded closed and prevents high pressure combustor air from entering the low pressure pneumatic duct.
- B. The starter low pressure air shutoff valve consists basically of a pneumatic actuator which incorporates a solenoid operated control valve and a shutoff valve assembly. The shutoff valve is comprised of an air flow duct and a sealing butterfly valve.
- C. Access to the starter low pressure air shutoff valve is provided by opening the engine side cowl panels. The shutoff valve is located in the three inch pneumatic duct going to the starter air inlet and is attached to the pneumatic duct by a clamp. (See figure 12.) A similar clamp attaches the opposite end of the low pressure air shutoff valve to the pneumatic starter air inlet duct.





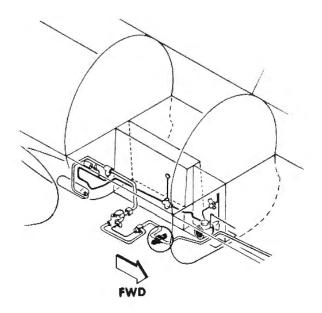
11. Bottle Discharge Pressure Regulating and Shutoff Valve

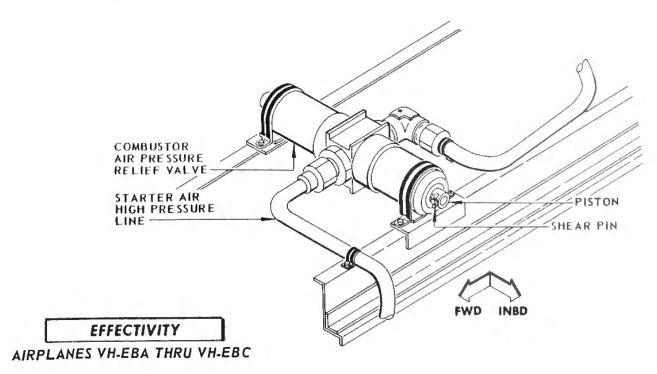
A. The bottle discharge pressure regulating and shutoff valve is located in the wing area forward of the right main landing gear strut. (See figure 13.) Access to the valve is gained through the right main landing gear wheel well. The valve controls the high pressure air to the combustion-pneumatic starter. A valve solenoid is energized to permit valve opening when the ground start selector switch is placed in the "HIGH PRESS" position and the engine start control switch is in the "GROUND START" position. The pressure regulating action of the valve meters bottle air pressure down to 750 psig for the combustor.



12. Combustor Air Pressure Relief Valve

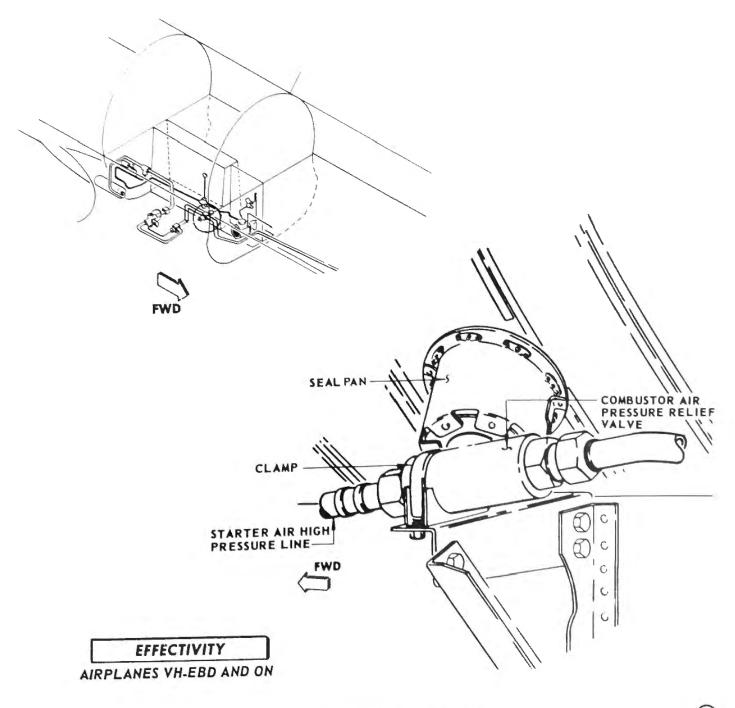
A. The combustor air pressure relief valve (figure 14 or 15) is installed in the starting system high pressure air line downstream of the bottle discharge pressure regulating and shutoff valve and is located on the outboard side of the right main landing gear wheel well, aft of the right main landing gear strut. In the event that the bottle discharge pressure regulating and shutoff valve malfunctions, the combustor air pressure relief valve will relieve air pressure in the starter air line when the pressure exceeds 1000 psig.







B. On airplanes VH-EBA thru VH-EBC a platon-type relief valve is installed. (See figure 14.) The double platons are retained by a connecting rod held in the valve by two shear pins. If the pressure reaches a predetermined value, the force on the internal platons will cause one or both shear pins to fall and thus allow both platons to move outward and relieve air pressure through holes in the platon shafts. On airplanes VH-EBD and on, the valve is a blow-out type and contains a rupture disk with a seal pan cover. (See figure 15.) It is designed to discharge high pressure air through an opening in the wing-body fairing. The opening is covered with a thin metal patch which is attached with 8 screws.





MAINTENANCE MANUAL

13. Starter Air Bottle Pressure Relief Valve

A. The starter air bottle pressure relief valve is located forward of the starter air bottle pressure transmitter. (See figure 1, 80-5-0.) The relief valve, identical to the relief valve located on the air compressor, prevents excessive build-up of pressure in the air bottle. The valve is set to relieve at 3450 (± 50) psig and to reseat at 3100 psig.

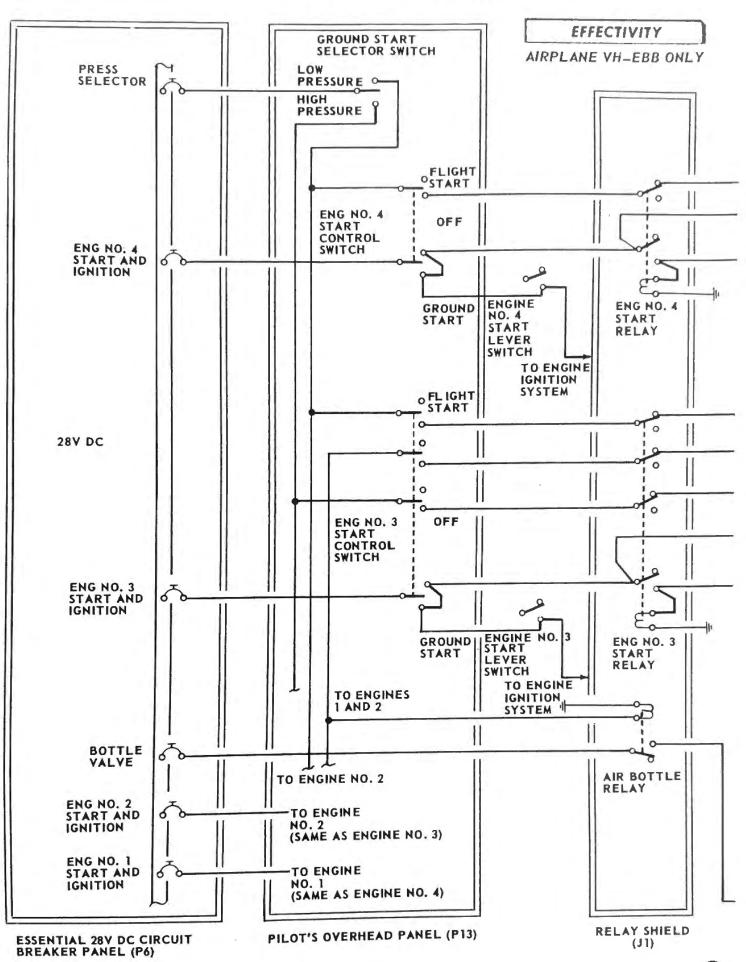
· 14. Starter Air Compressor Solenoid Valve

A. The starter air compressor solenoid valve is an electrically operated shutoff valve which controls the operation of the starter air compressor motor. The valve is attached to supporting structure by two bolts, and is located above the starter air compressor in the right-hand main wheel well. (See figure 7.) The valve solenoid operates on 28-volt d-c power controlled through a pressure switch and the air compressor cutout relay on the J1 relay shield. The cut-out relay is operated by the main landing gear door lock switches. (See figure 8.)

15. Operation

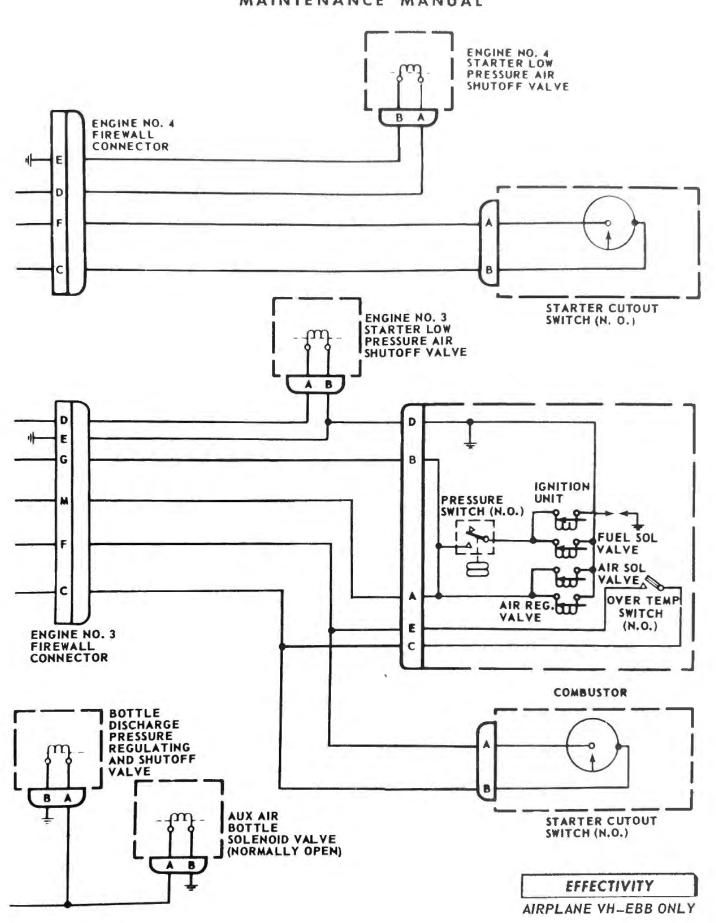
- A. Controls for the starting system are located on the overhead panel and consist of one ground start selector switch and four engine start control switches. Other controls used in conjunction with the starting system controls are the left and right wing isolation valve switches and the air conditioning control switches which are located on the flight engineer's upper panel. See "Pneumatic System", Chapter 36 and "Air Conditioning", Chapter 21.
- B. Power for control and operation of the starter system comes from the battery bus on the essential 28 volt d-c circuit breaker panel (P6).
- C. Starter operation is accomplished in the following four ways:
 - (1) Low pressure start using external air source.
 - (2) Low pressure start using airplane air source.
 - (3) High pressure start using external air source.
 - (4) High pressure start using airplane-contained air source.
- D. Low Pressure Start Using External Air Source
 - (1) This method of starter operation is good for all engines and is dependent upon having an external low pressure air source connected to the pneumatic ground service air connection.
 - (2) The left and right wing isolation valves must be in open position and the left and right air conditioning pack valves must be closed before a low pressure air source start is initiated.



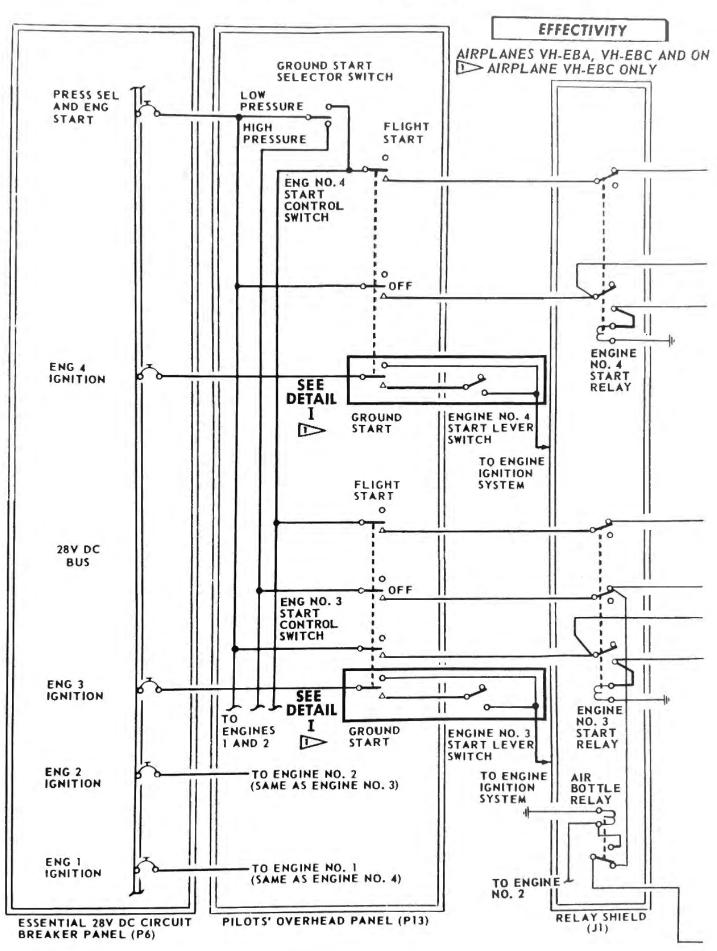


80-0 Page 30 Starting System Circuit Figure 16 (Sheet 1 of 2)

Dec 15/59 Revised

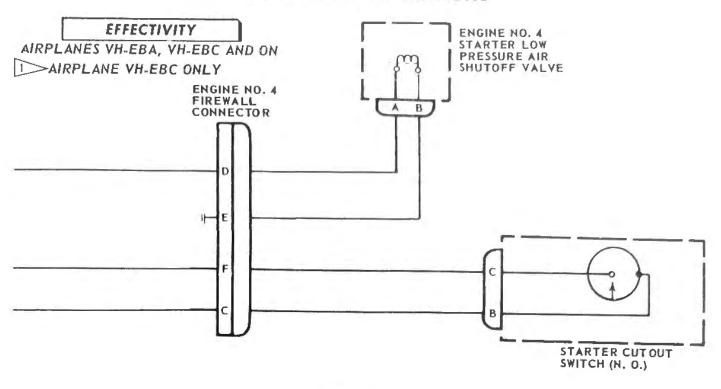


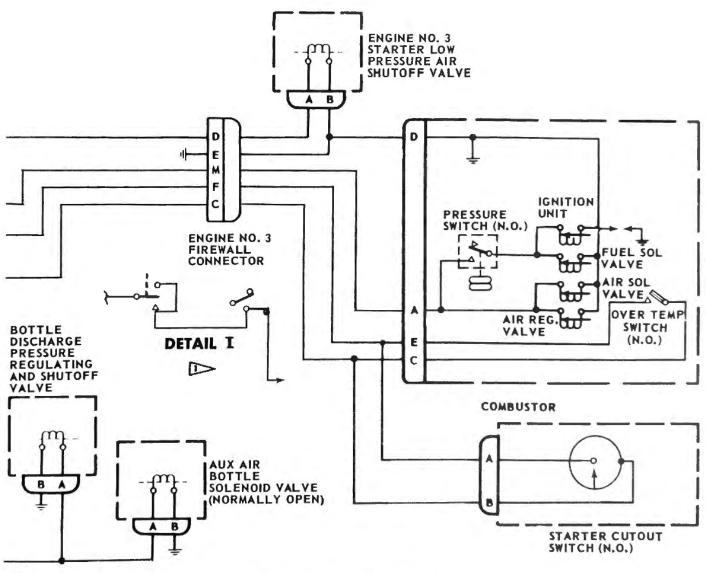




Starting System Circuit Figure 17 (Sheet 1 of 2)

Dec 15/59 Revised





Dec 15/59 Revised

Starting System Circuit Figure 17 (Sheet 2 of 2)

ENGINE NO. 2

STARTING Starting System Description and Operation

77777

MAIN CABIN TEMPERATURE CONTROL (HOT AIR) YALVE,

CONTROL CABIN

LH WING ISOLATION VALVE

TEMPERATURE

COMTROL (HOT AIR) VALVE

W

ENG NO. 2



PNEUMATIC STARTER



COMBUSTOR



SOLENOID OPERATED SHUTOFF VALVE



PRESSURE REGULATING AND SHUTOFF VALVE



COMBUSTOR AIR PRESSURE RELIEF VALVE



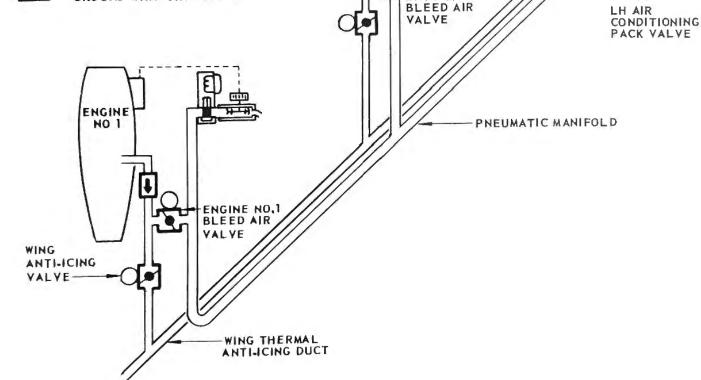
STARTER AIR BOTTLE PRESSURE RELIEF VALVE



STARTER AIR BOTTLE PRESSURE GAGE



STARTER AIR BOTTLE GROUND CHARGING VALVE





HIGH PRESSURE AIR SUPPLY SAFETY SOLENOID VALVE



CHECK VALVE



TURBOCOMPRESSOR



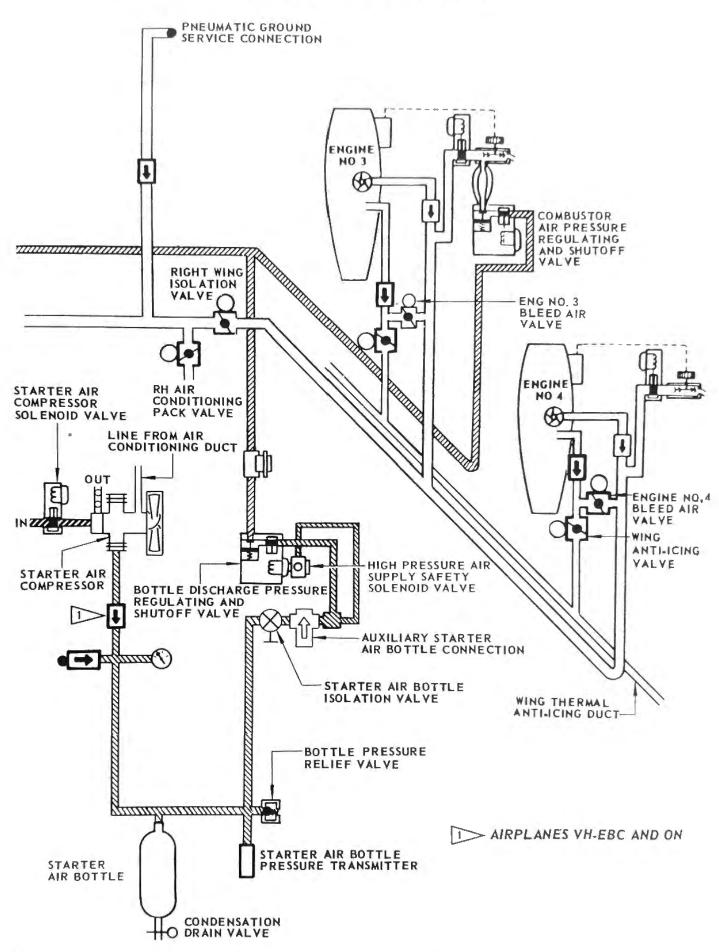
MOTOR DRIVEN SHUTOFF VALVE

HIGH PRESSURE AIR LINE

LOW PRESSURE AIR LINE

THE HYDRAULIC RETURN

TOOOOOOOO HYDRAULIC PRESSURE





- (3) When an engine start control switch is positioned to "GROUND START", and the ground start selector switch is in the "LOW PRESS" position, 28-volt d-c power is provided through the engine start relay contacts to open the starter low pressure air shutoff valve. (See figure 16 and 17.) This action allows low pressure air from the pneumatic manifold to energize the starter. (See figure 18.)
- (4) At the same time, the starter cutout switch circuit and the engine ignition circuit are supplied power. When the starter reaches cutout speed, 2300 to 2500 starter output shaft rpm, the cutout switch actuates to energize the start relay. Actuation of the start relay interrupts power to the starter low pressure air shutoff valve and causes the valve to shut off starter air supply from the pneumatic duct. Once the starter has reached cutout speed, the start relay will remain energized through a lock-in circuit as long as the engine start control switch is in the "GROUND START" position; this prevents any unintentional control cycling.
- E. Low pressure Start Using Airplane Air Source
 - (1) This method of starter operation is good for all engines and is dependent upon having either engine No. 2, 3 or 4 operating, so that turbocompressor output from the operating engine is directed into the pneumatic manifold.
 - (2) Control and operation are the same as for the low pressure start using external air source.
- F. High Pressure Start Using External Air Source
 - (1) This method of starter operation is good for engines No. 2 and 3 which are fitted with combustion-pneumatic starters, and are dependent upon having a 3000 psig air supply connected to the auxiliary starter air bottle ground connection.

PRIOR TO ATTACHING GROUND CART HOSE, CLOSE STARTER AIR BOTTLE ISOLATION VALVE. BLEED GROUND CART HOSE BEFORE DISCONNECTING. LEAVE ISOLATION VALVE IN CLOSED POSITION.



MAINTENANCE MANUAL

- (2) When an engine start control switch is positioned to "GROUND START" and the ground start selector is in the "HIGH PRESS" position, 28-v d-c power is provided through the air bottle relay and the engine start relay contacts. On airplanes VH-EBA, VH-EBC and on, power is supplied directly to actuate the bottle discharge pressure regulator and shutoff valve and the normally open auxiliary air bottle solenoid valve permitting control and regulation of the high pressure air directed to the combustor of the combustion-pneumatic starter (See figure 18.) On airplane VH-EBB the air bottle relay must be energized to allow electrical power to actuate the same components. At the same time, on all airplanes, the combustor circuit, the starter cutout switch circuit and the engine ignition circuit are supplied power. The power supplied to the combustor circuit actuates the fuel solenoid valve, ignition unit, air regulator valve and air shutoff solenoid valve. These actions result in high pressure combustor gases being directed to the turbine of the combustion-pneumatic starter (See figures 16 and 17.)
- (3) When the starter reaches cutout speed 2300 to 2500 starter output shaft rpm, the normally open cutout switch closes to energize the engine start relay. The energized engine start relay interrupts power to the combustor circuit components. On airplanes VH-EBA, VH-EBC and on, power is also interrupted to the bottle discharge pressure regulator and shutoff valve and the normally open auxiliary air bottle solenoid valve, while on airplane VH-EBB this action occurs after the air bottle relay is de-energized. Then, combustion-starter operation is shut down. Once the starter has reached cutout speed, the start relay will remain energized through a lockin circuit as long as the engine start control switch is in the "GROUND START" position, this prevents unintentional control cycling.
- G. High Pressure Start Using Airplane Contained Air Source
 - (1) This method of starter operation is also applicable to No. 2 or No. 3 engines and is dependent upon having the starter air bottle charged to 3000 psig, and the starter air bottle isolation valve in the open position.
 - (2) Control and operation are the same as for the high pressure start using external air source.

END

STARTING SYSTEM - MAINTENANCE PRACTICES

1. General

A. When any maintenance has been performed that would introduce air into the pressurizing fuel accumulator, the accumulator bleed plug must be removed and the air purged from the system.

2. Unit Servicing Starting System

A. General

(1) Servicing of the installed starters and starter air compressor is limited to draining and refilling, or adding oil to the lubricating oil sumps.

B. Service Starter

- (1) Drain and Refill Starter Lubricating Oil Sump
 - (a) Remove oil fill plugs and oil drain plug and allow oil to drain completely into a clean container. (See figures 2 and 4.)

CAUTION: DO NOT USE DRAINED OIL IF CONTAMINATED WITH FOREIGN MATERIAL OR METAL PARTICLES.

NOTE: The drained oil may be reused prior to oil change time if it is free of foreign material and metal particles.

- (b) Install oil drain plug and fill starter oil sump with 350 cubic centimeters of oil, MIL-L-7808. Replace oil fill plugs.
- (2) Add Oil to Starter Lubricating Oil Sump
 - (a) Remove starter right hand oil fill plug and check oil level.
 - (b) Add oil (MIL-L-7808) if necessary, to bring oil level to right hand oil fill plug opening. Replace oil fill plug.
- C. Service Starter Air Compressor
 - (1) Fill compressor oil sump with oil MIL-L-6085A (manufactured by Lehigh Chemical Co. or Anderson Co. only), until oil comes to top of oil sump sight glass. (See figure 7.)

3. Adjustment/Test Starting System

A. General

(1) Testing the starting system consists of testing each penumatic starter individually and then testing the starter air compressor and the combustor-pneumatic starter together.



B. Special Tools and Equipment

(1) Ground Low Pressure Air Source Boeing Turbine Compressor Model 502-11B or equivalent. The following output limits shall apply:

Maximum Air Outlet Temperature Maximum Air Outlet Pressure Minimum Delivery at 22 psig

46 psig 90 lbs/min

- (2) Air Source (Bottle Charging) 3000 psig Optional
- (3) Hydraulic Cart (using "Skydrol 500" hydraulic fluid) 6 gpm at 3000 psig nominal pressure. Optional use of airplane auxiliary hydraulic 3 gpm pump and external 3-phase a-c electrical power.
- (4) Ground electrical power 115/200 volt, 3-phase ac.

C. Test Pneumatic Starter

- (1) Ground airplane to an approved grounding lug.
- (2) Connect external electrical power to airplane.
- (3) Close applicable circuit breakers on essential 28-volt dc bus (Panel P6): On airplanes VH-EBA and VH-EBC and on close "PRESS SEL & ENG START" circuit breaker and engine "IGNITION" circuit breakers. On airplane VH-EBB close engine "START & IGNITION" circuit breakers and "PRESS SEL" circuit breaker. On all airplanes close "ENGINE IGNITORS" circuit breakers.
- (4) Connect ground cart to pneumatic ground service connection.
- (5) Place ground start selector switch to "LOW PRESS". Position air conditioning control switches to "OFF". Air conditioning pack shutoff valves should close. Check external indicator on valves located in air conditioning equipment bay. Refer to 21-2-0, "Air Conditioning Air Cycle."
- (6) Place left and right wing isolation valve switches to "OPEN" position. Check external indicator on valves located in air conditioning distribution bay. Refer to 36-2-1, "Pneumatic Valves".
 - NOTE: The wing isolation valves should now be open so that external low pressure air can be directed to the starter low pressure air shutoff valves on each engine.

- (7) With ground service cart operating, place engine start control switch for starter to be tested to "GROUND START". The starter low pressure air shutoff valve should open. Check external indicator on valve located adjacent to pneumatic starter.
- (8) Continue with normal start procedure. Starter should motor N₂ compressor to 31 35% rpm in 20 seconds.
 - (a) At 34% rpm starter cutoff switch should close, causing starter low pressure air shutoff valve to close. Check external indicator on valve to verify that valve is closed.
- (9) Test each pneumatic starter in the same manner.
- D. Test Combustion-Pneumatic Starter
 - (1) Ground airplane to an approved grounding lug.
 - (2) Connect external power to airplane.
 - (3) Open applicable circuit breakers on essential 28-volt dc bus (Panel P6): On airplanes VH-EBA and VH-EBC and on open "PRESS SEL & ENG START" circuit breaker and engine "IGNITION" circuit breakers. On airplane VH-EBB open engine "START & IGNITION" and "BOTTLE VALVE" circuit breakers and "PRESS SEL" circuit breaker. On all airplanes open "ENGINE IGNITORS" circuit breakers.
 - (4) Open "AIR COMPRESSOR TIMER" circuit breaker.
 - (5) Open "START AIR COMP CONT" circuit breaker.
 - (6) Test Starter Air Compressor
 - (a) Provide hydraulic power for starter air compressor motor operation.
 - (b) Check that compressor is serviced to proper oil level.
 - (c) Open "LANDING GEAR IND. LTS. AND ANTI-SKID RELAY" circuit breaker.
 - (d) Close "START AIR COMP CONT" circuit breaker.
 - NOTE: If the starter air bottle pressure drops to 2700 psig or less, the compressor will operate to charge the bottle to 3100 (± 100) psig and stop.



(e) Close "AIR COMPRESSOR TIMER" circuit breaker.

WARNING: KEEP HEAD AND FACE CLEAR OF COMPRESSOR DRAIN SINCE MOISTURE AND AIR ARE EXPELLED WITH CONSIDERABLE FORCE.

NOTE: At least every 20 minutes the timer allows the compressor to cut off for a period less than 1 minute. This provides a means of blowing moisture out of the air compressor drain line.

- (f) To reduce operation time of the starter air compressor the air bottle may be charged to not more than 2700 psig through the starter air bottle ground charging valve.
- (g) Check for air leakage at all connections and fittings in the starter air bottle charging system. There should be no leakage.
- (h) Deleted
- (7) Supply fuel to charge the starter fuel accumulator.
 - NOTE: Remove the starter fuel accumulator air purge plug until clear fuel is expelled, then install and lockwire air purge plug. If airplane engine is primed, fuel will siphon from its respective tank; if engine is not primed, the head of fuel in the tank must be equivalent to at least 85% full.
- (8) Close applicable circuit breakers on essential 28-volt dc bus (Panel P6): On airplanes VH-EBA and VH-EBC and on, close "PRESS SEL & ENGINE START" circuit breaker and engine "IGNITION" circuit breakers. On airplane VH-EBB close engine "START & IGNITION" and "BOTTLE VALVE" circuit breakers and "PRESS SEL" circuit breaker. On all airplanes close "ENGINE IGNITORS" circuit breakers.
- (9) Place ground start selector switch to "HIGH PRESS".
- (10) Operate combustion-pneumatic starter by placing applicable engine start control switch to "GROUND START".
- (11) Continue with normal start procedure. Starter should motor N_2 compressor to 31-35% rpm in 10 seconds.
 - NOTE: The combustion-pneumatic starter should operate through one cycle and shut down. The time required for the starter to raise the N₂ compressor rpm to cutoff speed is approximately 10 seconds under normal conditions.
 - NOTE: A fully charged air bottle should be used for each start when checking starter performance.

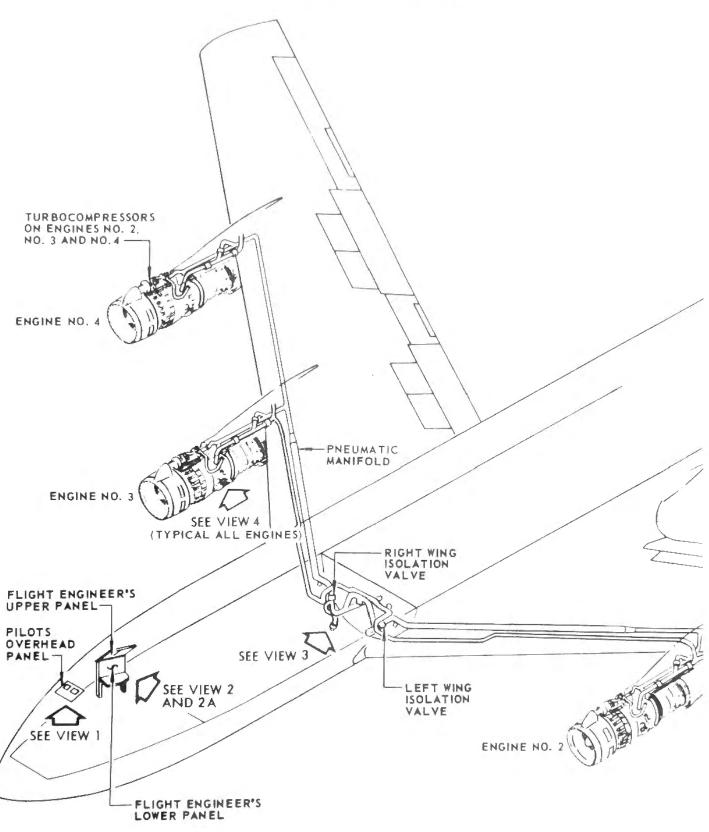


STARTING SYSTEM - DESCRIPTION AND OPERATION

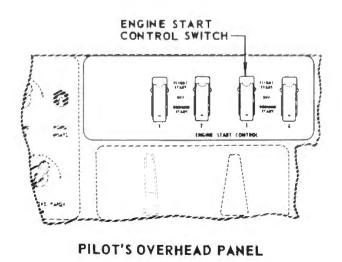
1. General

- A. The starting system provides a means of rotating the N₂ engine compressor to a speed at which an engine start may be accomplished when fuel and ignition are supplied. Each engine is equipped with a combination high/low pressure pneumatically operated starter. The starters are not serviced with high pressure air and operate only as low pressure starters (figure 1). Each starter is geared to the N₂ compressor through the engine accessory drive gear case.
- B. The components comprising the starting system (figure 1) are: four high/ low pressure air starters, four starter low pressure air shutoff valves, a low pressure pneumatic manifold, a low pressure air ground connection, and associated valves which regulate and control the distribution of low pressure air.
- C. All starters may be operated by low pressure air supplied through the pneumatic manifold from an operating turbocompressor on engines No. 2, No. 3 or No. 4; or from a low pressure air ground service cart. The cart connects to the manifold through an external pneumatic ground service connection on the right side of the fuselage forward of the wing (view 3, figure 1.) Refer to Chapter 36, "Pneumatic System," for information on the turbocompressors and the pneumatic manifold.
- D. The switches that control the starting operation are located on the pilots' overhead panel and on the flight engineer's upper and lower panels (figure 1).





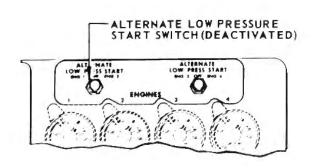




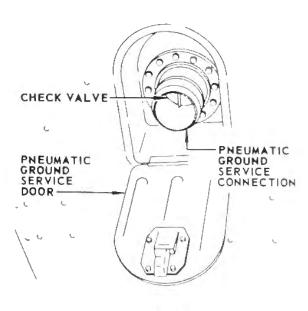
VIEW 1

DUCT PRESSURE INDICATOR

FLIGHT ENGINEER'S UPPER PANEL
VIEW 2



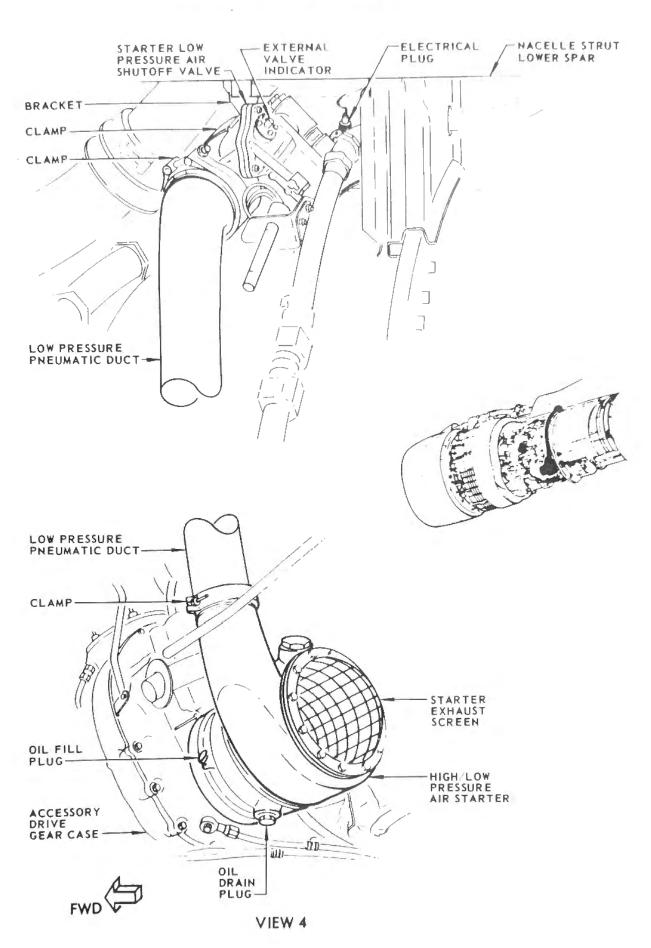
FLIGHT ENGINEER'S LOWER PANEL IN VIEW 2A



VIEW 3

VH-EBL AND ON







2. High/Low Pressure Air Starter

A. General

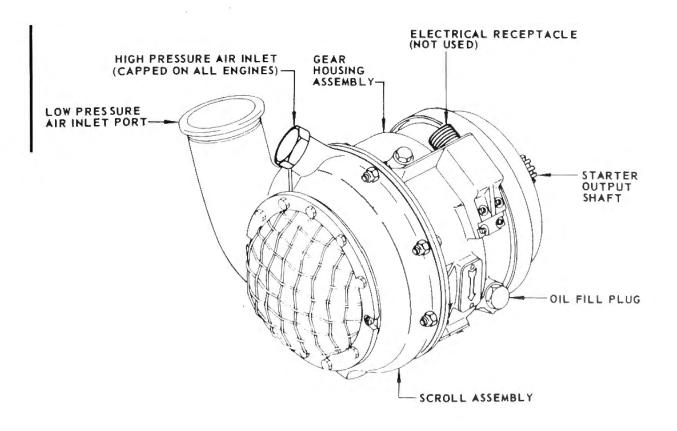
(1) The high/low pressure air starter (figure 2) is an air driven turbine motor which produces a rotational mechanical energy sufficient to accelerate the engine to starting speed. After engine light-up it continues to assist the engine until 33 to 35% N2 RPM is attained. The starter is serviced only by low pressure air. The starter consists of a rotor, reduction gear assembly, engagement mechanism and output shaft, and a cutout switch mechanism. The cutout switch mechanism is deactivated. All these components are contained within the scroll and gear train housing.

B. Rotating Assembly

(1) The rotor assembly consists of a one piece turbine wheel and shaft, a spacer, a spur gear, and a nut.

C. Reduction Gear Assembly

(1) The reduction drive is obtained through a planetary gear assembly consisting of a gear carrier assembly, three spur gearshafts, an internal gear and an internal hub. The gear hub is externally splined to support the drive jaw of the engagement mechanism.





- D. Engagement Mechanism and Output Shaft
 - (1) The engagement mechanism is essentially a triple ratchet drive which locks the starter to the engine until the engine accelerates above starter speed. The ratchets then allow disengagement between the starter and engine gear train. The assembly consists of a drive shaft, three pawl springs and three drive shaft pawls. The drive shaft is internally threaded for installation of the cutout switch actuating governor assembly and internally splined for installation of the output shaft. The output shaft is designed to serve as a shear section.
- E. Cutout Switch Mechanism
 - (1) The starter cutout switch unit is deactivated.
 - (2) and (3) Deleted
- F. Scroll Assembly
 - (1) The scroll assembly surrounds the turbine wheel and is provided with a flanged inlet port for low pressure air and a threaded high pressure inlet connection. It is also provided with a screened exhaust port. A heat barrier is an integral part of the scroll assembly and prevents compressed air from entering the gear housing assembly.
- G. Housing Assembly
 - (1) The housing assembly encloses the reduction gear system, engagement mechanism, cutout switch mechanism, and output shaft. The housing includes the electrical receptacle for the cutout switch and also the oil fill and drain ports. A name and modification plate as well as the lubrication data plate are attached to the housing. A flange on the end of the housing mates with adapter plate attached to the engine gearbox.



F. Scroll Assembly

(1) The scroll assembly encloses the turbine wheel portion of the rotating assembly, provides air inlet and exhaust connections, and incorporates self-contained turbine nozzle vanes. The scroll assembly is secured to the housing assembly with a heat barrier installed between the flanges. Shims placed between the heat barrier and the flange of the housing assembly provide a means for obtaining the correct clearance between the front face of the turbine wheel and the interior of the scroll assembly. The scroll assembly may be rotated about the axis of the starter, to any position required to align the air inlet connection with the pneumatic duct, by loosening the eight attaching nuts.

G. Housing Assembly

(1) The housing assembly encloses the reduction gear system, engagement mechanism, cutout switch mechanism, and output shaft. The housing also provides mounting provisions for the electrical receptable and oil fill and drain ports. The name and modification plates as well as the lubrication data plate are attached to the housing. A flange is cast integrally with the housing and mates with a mounting adapter plate by means of a guide attach-detach clamp.

3. High Pressure Air Starter

A. General

(1) The high pressure air starter (figure 4) consists essentially of the same components as the low pressure air starter. The high pressure air starter is a dual purpose starter, which may be operated by high or low pressure air. An inlet port fitting on top of the scroll assembly is provided to supply high pressure air into the starter, and when electrical energy is used to operate the other components in the system, a high pressure start would be attained. Mentioned below are the high pressure starter components that differ from the low pressure starter components.



3. Starter Low Pressure Air Shutoff Valve

- A. The starter low pressure air shutoff valve (figure 1) controls the air supply from the air conditioning pneumatic duct to the starter. The valve is basically a pneumatic actuator, incorporating a solenoid-operated valve control and a shutoff valve assembly. The shutoff valve is an air flow duct containing a butterfly valve.
- B. The starter low pressure air shutoff valve is located at the bottom of the nacelle strut. The valve is connected to the pneumatic ducts by clamps.
- C. The starter low pressure air shutoff valve relies on air pressure to keep it closed. When the engine start control switch is placed in the "GROUND START" position the valve is opened by the solenoid-actuated valve control and low pressure air is then routed to the low pressure air starter.

4. Operation

- A. Controls for the starting system are located on the pilot's overhead panel and flight engineer's lower panel (figure 1). The switches on the pilot's overhead panel consist of four engine start control switches. On airplanes VH-EBL and on, the flight engineer's lower panel has two alternate low pressure start switches. The alternate low pressure start switches are, however, presently deactivated. Other controls used in conjunction with the starting system controls are the left and right wing isolation valve switches, the engine bleed air switches, the air conditioning control switches and the air supply duct pressure indicator, located on the flight engineer's upper panel. Refer to Chapter 36, "Pneumatic System" and Chapter 21, "Air Conditioning" for the integration of these systems with starting.
- B. Power for control and operation of the starting system is obtained from the battery bus on the essential 28V d-c circuit breaker panel (P6). (See figure 4.)
- C. Starter operation can be accomplished by using either airplane air source, or an external air source.
- D. Start Using External Low Pressure Air Source
 - (1) This method of starter operation is applicable to any engine and is dependent upon having an external low pressure air source connected to the pneumatic ground service connection (figure 1).

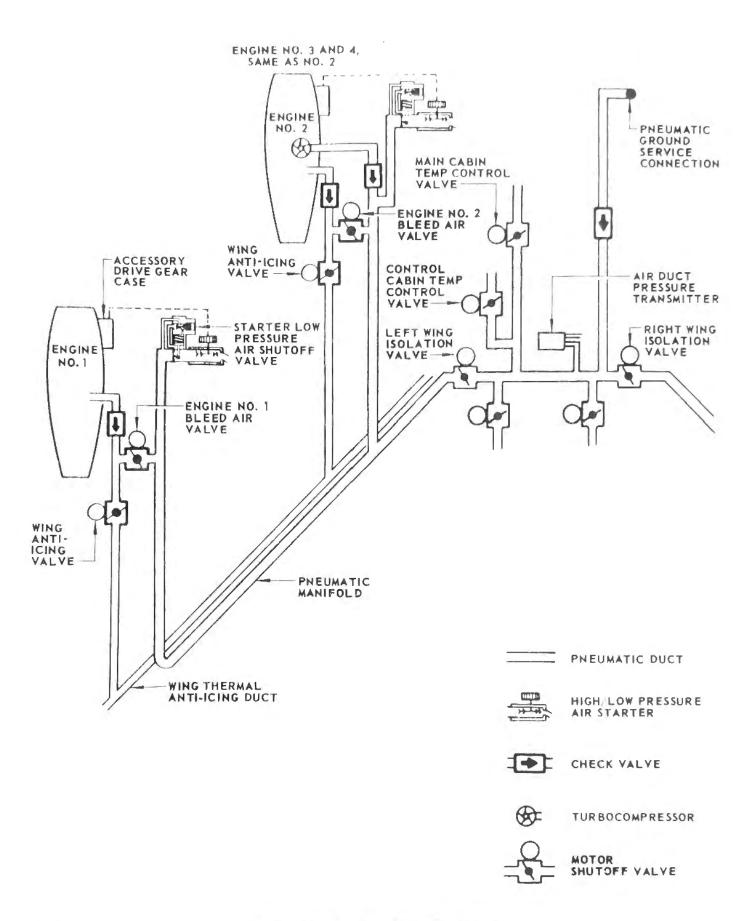


(2) The air conditioning control switches should be in the "OFF" position. This will ensure that the control cabin and main cabin temperature control valves and the air conditioning pack shutoff valves are closed. The engine bleed air valve switches should be in the closed position, and the left and right wing isolation valves must be in the open position. When an engine start control switch is positioned to "GROUND START," power is supplied to the solenoid on the starter low pressure air shutoff valve. This action completes the electrical circuit and the valve opens. Air from the pneumatic manifold then drives the starter. (See figure 3.) When the engine reaches 33 to 35% N2 RPM, the start control switch is released. This de-energizes the solenoid in the starter low pressure air shutoff valve. The valve closes and the starting operation is terminated. (See figure 4.)

WARNING: ENGINE N2 RPM SHOULD BE MONITORED CLOSELY TO PREVENT OVERSPEEDING OF STARTER.

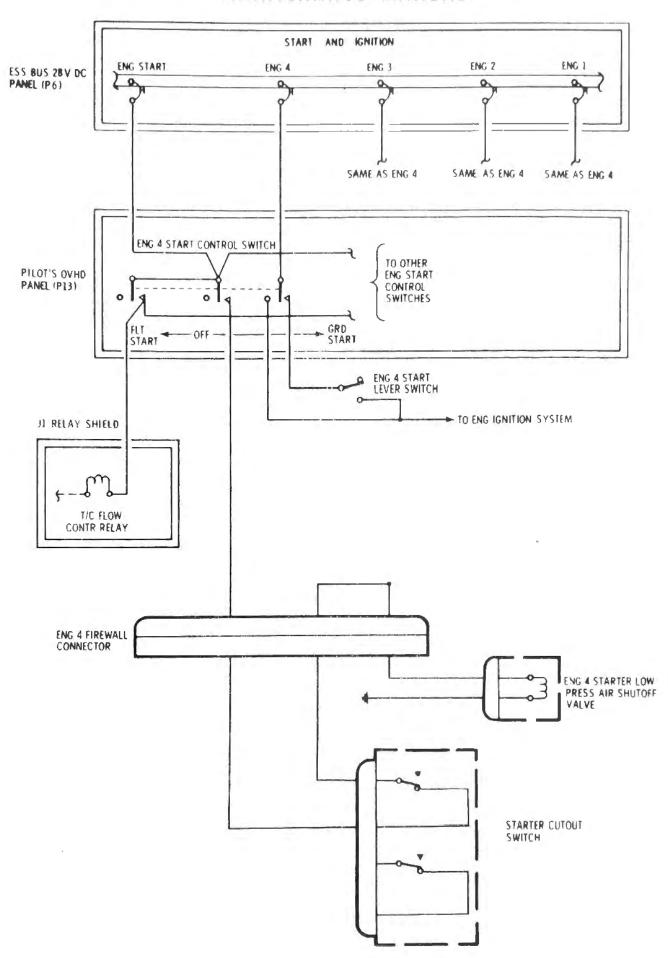
- (3) The air duct pressure indicator (figure 1) gives an indication of ground air supply or turbocompressor output, and may be used to monitor starting. When the pneumatic duct network is pressurized by either of the low pressure sources and the starter valve is closed; duct pressure is indicated. When the starter valve is opened there will be a sudden drop in duct pressure and when the starter valve closes, a subsequent recovery of duct pressure will occur.
- (4) Deleted
- E. Start Using Airplane Air Source
 - (1) This method is dependent upon having engine No. 2, 3 or 4 operating, so that its turbocompressor output is directed into the pneumatic manifold. The air supplied can then be used for starting the remaining engines. With start control switch in "GROUND START" the turbocompressor flow control valve is energized to operate the turbocompressor at an adequate output (ground mode).
 - (2) Control and operation are the same as for the start using external air source.
 - (3) The low pressure engine bleed can also be used for cross starting engines. However, this is undesirable because a 90 to 95% N2 RPM is required on operating engine to develop adequate pressure for starting another engine.





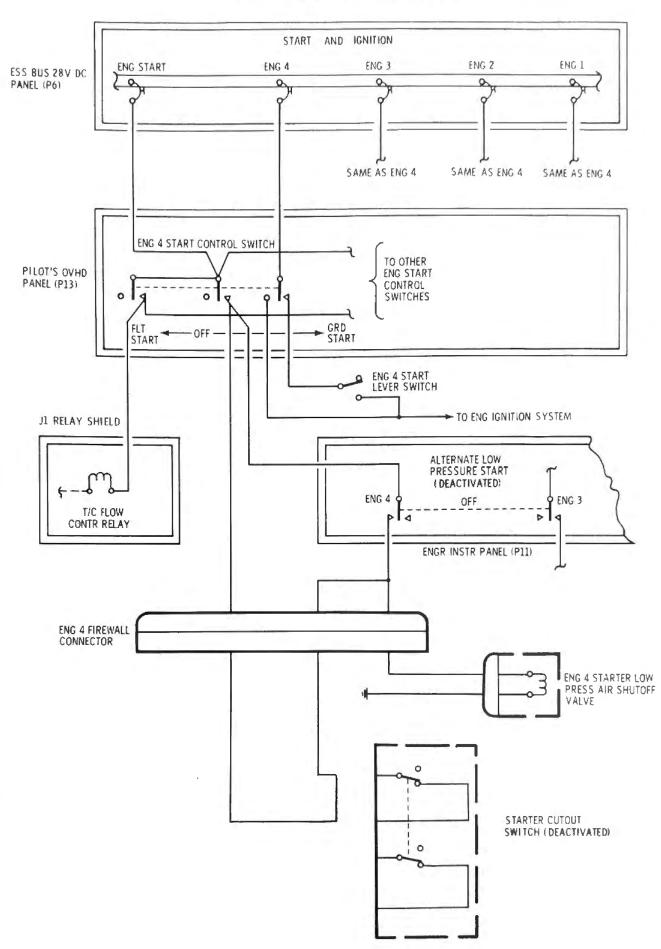


VH-EBA THRU VH-EBK









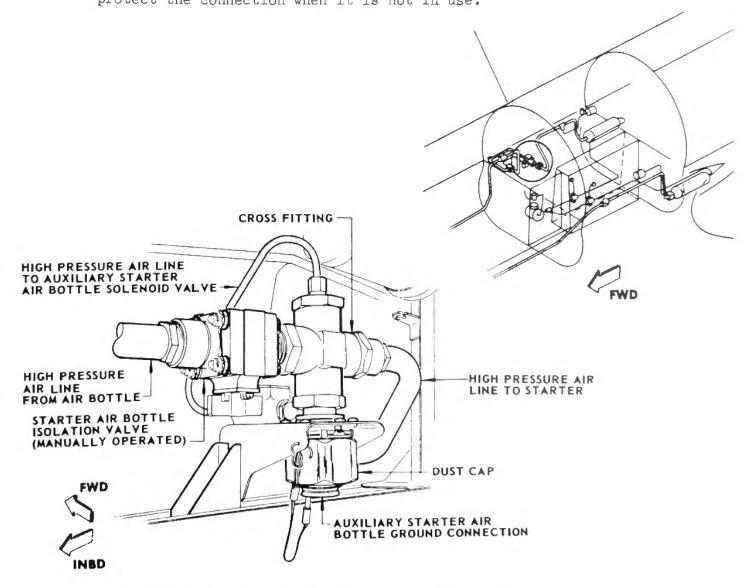


7. Starter Air Bottle Isolation Valve

A. The manually operated starter air bottle isolation valve (figure 8) is located in the wing area forward of the right main landing gear strut and is installed with the cross fitting that holds the auxiliary starter air bottle ground connection. With the valve in the closed position, the starter air bottle is isolated from the system and air is supplied from the auxiliary starter air bottle ground connection. In the open position, the valve incorporates the air bottle into the system. This condition allows high pressure air from a fully charged bottle to be used for high pressure starter operation.

8. Auxiliary Starter Air Bottle Ground Connection

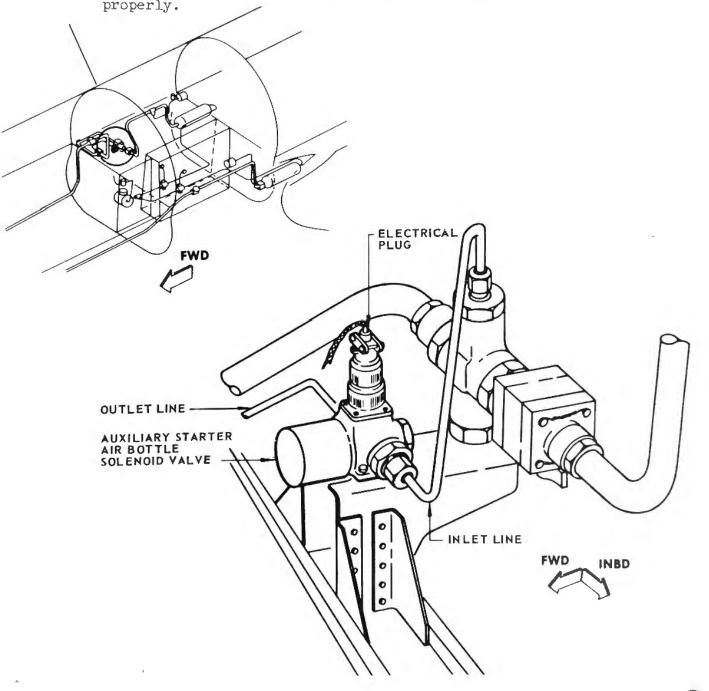
A. An auxiliary starter air bottle ground connection (figure 8) is provided for attaching the ground equipment which supplies the high pressure air (3000 psig) necessary for a high pressure start. The auxiliary starter air bottle ground connection is located in the wing area forward of the right main landing gear strut. Access to the connection is gained through the right main landing gear wheel well. A cap is provided to protect the connection when it is not in use.



STARTING
Starting System
Description and Operation

9. Auxiliary Starter Air Bottle Solenoid Valve

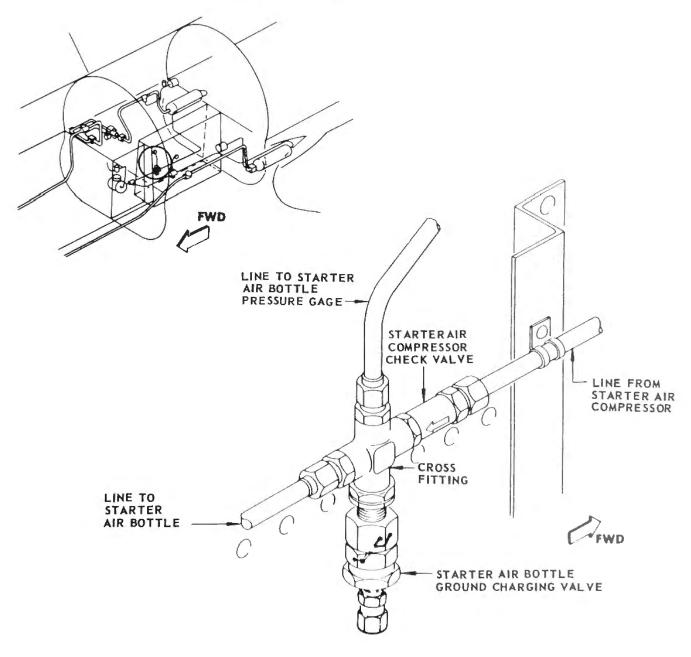
- A. The auxiliary starter air bottle solenoid valve (figure 9) is a normally open valve that is utilized to prevent malfunction of the bottle discharge pressure regulating and shutoff valve when an external high pressure air source is connected. The valve is located immediately forward of the auxiliary starter air bottle ground connection, and is installed in an air line connecting the downstream side of the regulating valve piston to the high pressure line upstream of the valve.
- B. When a high pressure start has been selected and the engine start switch for engine number 2 or 3 is in "GROUND START" the solenoid valve closes and allows the pressure regulating and shutoff valve to function properly.





10. Starter Air Bottle Ground Charging Valve

- A. The starter air bottle ground charging valve is a standard high pressure air charging valve. It is located approximately midway in the right main landing gear wheel well on the inboard side. (See figure 10.) The charging air valve is connected in the compressor-to-bottle line through a cross fitting. The line to the pressure gage, located above the charging air valve, also connects to this fitting.
- B. The starter air bottle ground charging valve consists of a stem, 0-ring seals, and a body and nut assembly. The stem is protected from thread damage and against the entry of foreign matter by a cap. The ground charging valve is opened to admit outside source air pressure by turning the 3/4 inch nut counterclockwise to a maximum of 2-1/4 turns. This unseats the valve.





11. Starter Air Compressor

- A. The starter air compressor (figure 11), is a hydraulically driven four-stage radial compressor. The hydraulic drive motor is automatically controlled through a solenoid operated valve which in turn is electrically controlled by an air pressure switch. The compressor maintains a 2800 to 3100 psig air bottle charge for combustion-pneumatic starter operation. Air is supplied to the starter air compressor by a bleed line connected to an air conditioning duct. An air filter is installed at the air compressor inlet to the first stage. The starter air compressor is located in the right main landing gear wheel well on the inboard side.
- B. The starter air compressor consists of the hydraulic motor, a compressor section, and several accessory items for protection and control. The compressor has an intercooler between each stage and an aftercooler. Pressure relief valves are located between compressor stages one and two and between two and three. Lubrication of the compressor is provided by an integral lube oil pump and sump. A sump oil fill line is located on top of the sump housing and extends to the top level of the compressor. An oil sump sight glass provides visual indication of lubricating oil level.
- C. An air filter is included on the air inlet side of the compressor. Inlet air pressure is controlled by the pressure in the air conditioning duct. The accessory items on the air outlet side include: a system emergency pressure relief valve, a moisture separator, moisture separator timer and relay assembly, back pressure valve, check valve, pressure relief valve, and a pressure switch.
 - (1) Excessive moisture is extracted from the air by the moisture separator before the air enters the air bottle. The moisture separator includes a thermostatically controlled heater to prevent freezing of accumulated moisture. The moisture separator heater switch opens at 75°F and closes at 45°F.
 - (2) Incorporated in the compressor unit is the moisture separator timer which operates on 115-volt a-c power and controls the drain valve. The timer points are normally closed and are opened for 5 to 45 seconds every twenty minutes of compressor operation. This action causes the moisture separator drain valve to open and discharge accumulated moisture. With an increasing pressure the normally closed pressure switch opens at 3100 psig. The switch returns to its normally closed position when the pressure has decreased to 2800 psig. Air pressure differential between opening and closing pressures should be 200 psi minimum.

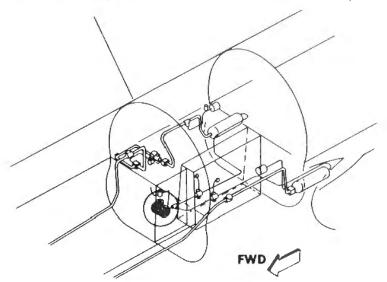


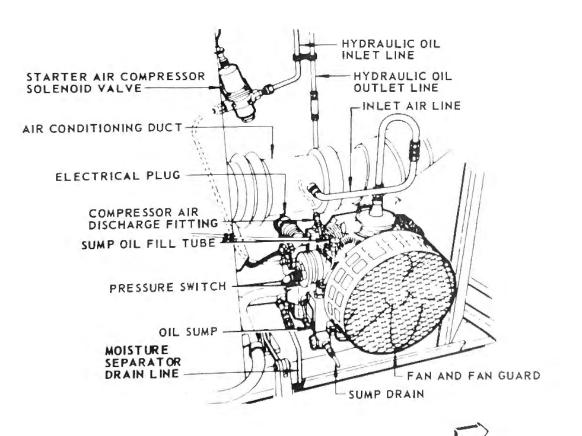
- D. The starter air compressor is powered by a fixed displacement continuous service type hydraulic motor with an integral speed control. The speed is limited by a hydraulic oil control valve. The compressor delivery rate is 0.30 lb/min at 3100 psig at a rated speed of 4200 rpm. The corresponding hydraulic flow is 4.6 gpm.
- E. Starter Air Compressor Operation
 - (1) Hydraulic power to the starter air compressor motor is controlled by a starter air compressor solenoid valve. The electrical power to the valve solenoid is controlled by an integral pressure switch on the starter air compressor to automatically control the compressor. (See figure 12.) Landing gear door lock switches also control the air compressor during landing gear operation through the compressor control relay.
 - (2) With electrical power on the starter air compressor control circuit, the landing gear doors closed and locked and hydraulic power on the utility system, the starter air compressor will run if the starter air bottle pressure is 2800 psig or lower. This level of pressure causes the air compressor integral pressure switch to close and allows 28-volt d-c power from the radio and T-R circuit breaker panel (P5) to energize the air compressor solenoid valve.
 - (3) Power from the a-c bus No. 3 circuit breaker panel (P3) provides 115-volt a-c, through the compressor control relay, to the air compressor integral timer and relay assembly to run the timer motor. The air compressor integral pressure switch also controls the relay in the timer and relay assembly. The timer unit allows the moisture separator to drain by interrupting electrical power to the compressor solenoid valve and causing compressor cut off for 5 to 45 seconds every 20 minutes.
 - (4) The compressor continues to run until air pressure in the starter air bottle reaches 3100 psig. At this pressure the integral pressure switch contacts open and disconnect 28-volt d-c power from the air compressor solenoid valve. Hydraulic power is stopped and the compressor stops running.



12. Starter Air Compressor Solenoid Valve

A. The starter air compressor solenoid valve is an electrically operated shutoff valve which controls the operation of the starter air compressor motor. The valve is attached to supporting structure by two bolts, and is located above the starter air compressor in the right main landing gear wheel well. (See figure 11.) The valve solenoid operates on 28-volt d-c power controlled through a pressure switch and the air compressor cutout relay on the J1 relay shield. The cutout relay is operated by the main landing gear door lock switches. (See figure 12.)





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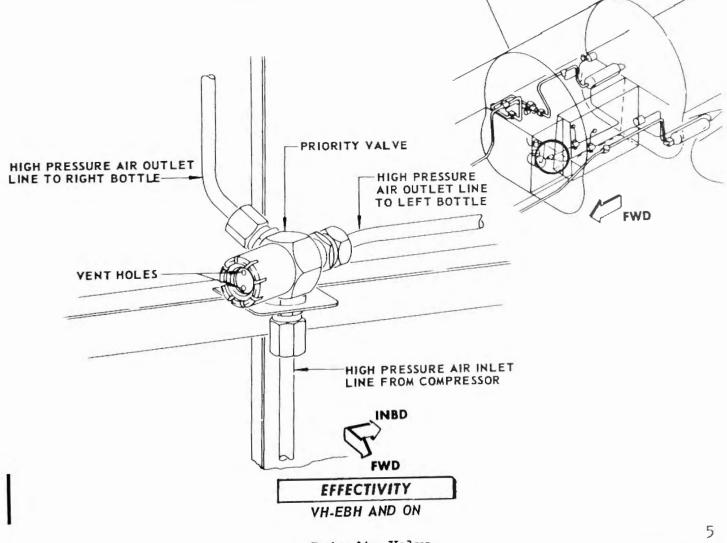
Air Compressor Control Circuit Figure 12

Starter



13. Starter Air Compressor Priority Valve (Airplanes VH-EBH and on)

- A. The starter air compressor priority valve (figure 13) is located on the inboard side of the right main landing gear wheel well and connected to the compressor-to-bottle charging line. The valve has three ports: the inlet port connected to the outlet line of the compressor, the bypass port which is a free flow conduit directed to charge the right starter air bottle, and the outlet port connected to the line charging the left starter air bottle. The outlet port operates as a check valve and opens only at the predetermined pressure.
- B. The starter air compressor priority valve reduces the time required to charge a single bottle when both bottles have been discharged. High pressure air from the compressor is ducted by the priority valve to charge first the right starter air bottle until the bottle is charged to 2800 (± 50) psig. At this pressure the priority valve outlet port opens and air from the compressor is allowed to flow to the left starter air bottle. If a residual pressure of 1000 psig and up is present at the left starter air bottle, the priority valve opens between 2600 and 2850 psig. When the priority valve is open and pressure in bottles is equal, compressor air flows to both bottles until 3100 psig pressure is reached. At this condition the compressor pressure switch shuts down the compressor operation.



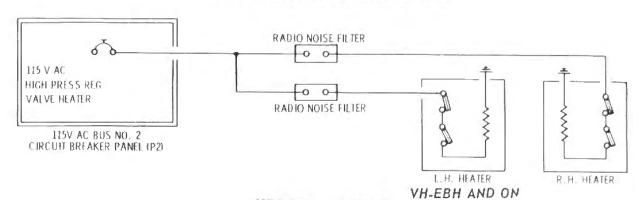
5 Jun 15/61 Revised



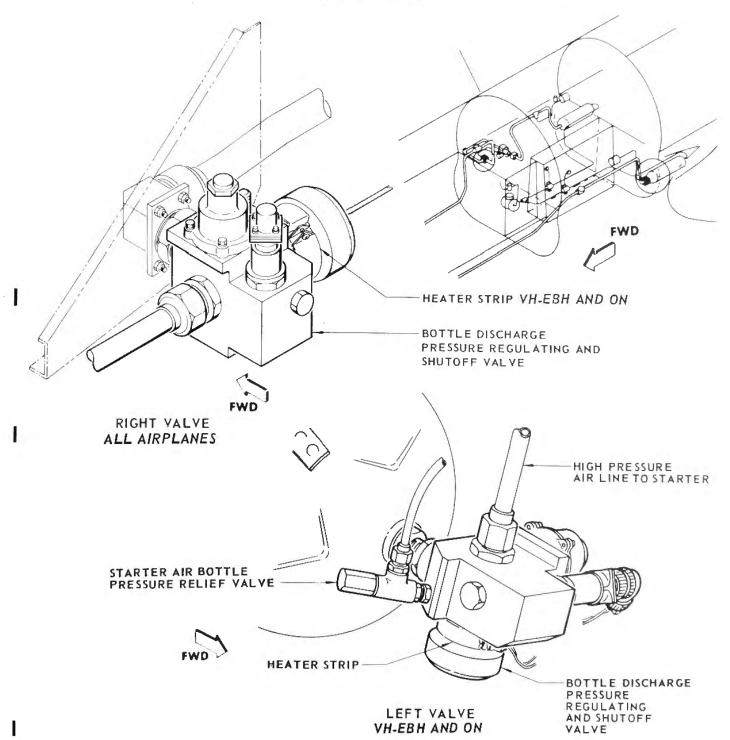
14. Bottle Discharge Pressure Regulating and Shutoff Valve

- A. The right bottle discharge pressure regulating and shutoff valve is located in the wing area forward of the right main landing gear strut. On airplanes VH-EBH and on a left valve is located at the forward end of the left starter air bottle. (See figure 14.) Access to the valves is gained through the main landing gear wheel well. The valves control the high pressure air to permit valve opening when the ground start selector switch is placed in the "HIGH PRESS" position and the engine start control switch is in the "GROUND START" position. The pressure regulating action of the valve meters bottle air pressure down to 750 psig for the high pressure air starter.
- B. An electric heater strip is wrapped around one end of each bottle discharge pressure regulating and shutoff valve to improve the reliability of the valves during cold weather operation. The heater operates on 115 volt a-c electrical power whenever the airplane a-c electrical system is in operation. The heater circuit comprises an operating thermostat and a safety thermostat and a safety thermostat connected in series to control the operation of the heater. The operating thermostat maintains the valve temperature at 100° to 115°F and the safety thermostat prevents overheating the valve above 122° to 142°F.





HEATER CIRCUIT



5 Jun 15/61 Revised

Bottle Discharge Pressure Regulating and Shutoff Valve Figure 14

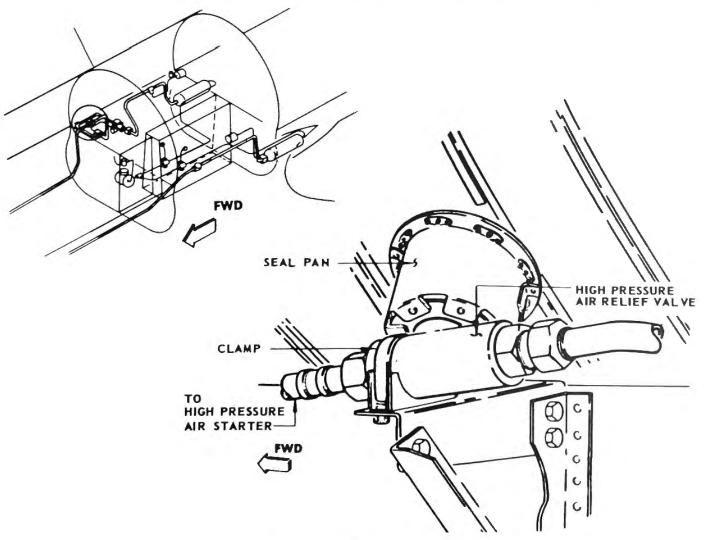


15. High Pressure Air Relief Valve

- A. A high pressure air relief valve is installed in the starting system downstream of each bottle discharge pressure regulating and shutoff valve. The relief valves are located in the main landing gear wheel wells in the wing area forward of the landing gear strut. (See figure 15.)
- B. The valve is designed to relieve air pressure in the starter air lines in excess of 1000 psig. In the event that the bottle discharge pressure regulating and shutoff valve malfunctions, the high pressure air relief valve will prevent air pressure greater than 1000 psig in the line to combustor on the starter.

16. Operation

A. Controls for the starting system are located on the overhead panel and consist of one ground start selector switch and four engine start control switches. Other controls used in conjunction with the starting system controls are the left and right wing isolation valve switches, the engine bleed valve switches and the air conditioning control switches located on the flight engineer's upper panel. Refer to Chapter 36, "Pneumatic System" and Chapter 21, "Air Conditioning."



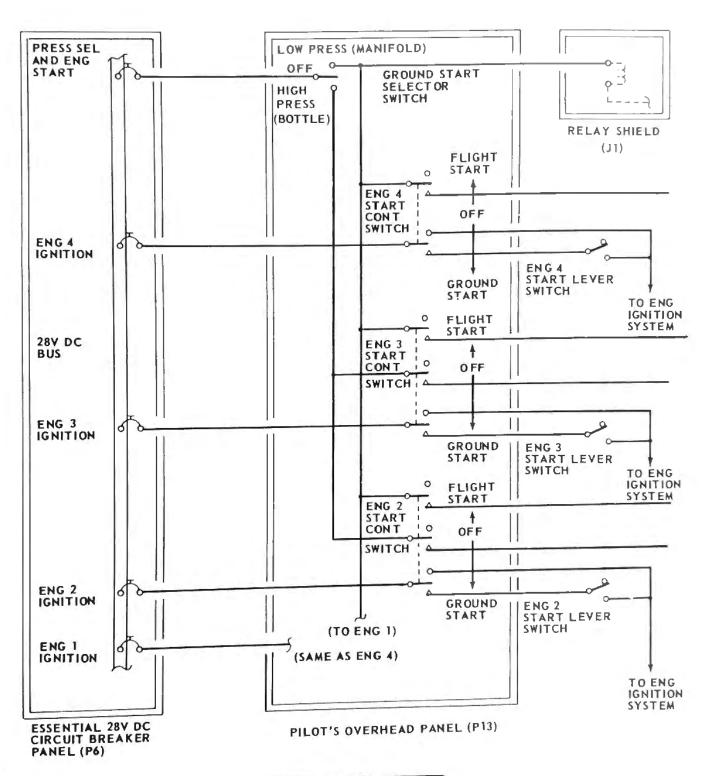


MAINTENANCE MANUAL

- B. Power for control and operation of the starting system is supplied from the battery bus on the essential 28-volt d-c circuit breaker panel (P6).
- Starter operation may be accomplished in the following four ways:
 - (1) Low pressure start using external air source
 - (2) Low pressure start using airplane air source
 - (3) High pressure start using airplane-contained air source
 - (4) High pressure start using external air source
- Low Pressure Start Using External Air Source
 - (1) This method of starter operation is applicable to all engines and is dependent upon having an external low pressure air source connected to the pneumatic ground service air connection. The left and right wing isolation valves must be open and the engine bleed air valves and air conditioning pack valves must be closed before a low pressure start is initiated.
 - (2) When an engine start control switch is positioned to "GROUND START" and the ground start selector switch is in the "LOW PRESS" ("MANIFOLD") position, 28-volt d-c power is supplied through the starter cutout switch to provide electrical power to open the starter low pressure air shutoff valve. (See figure 16.) This action allows low pressure air from the pneumatic manifold to energize the starter. (See figure 17.)
 - (3) If the starter reaches cutout speed, 2300 to 2500 output shaft rpm, the cutout switch actuates and interrupts power to the starter low pressure air shutoff valve which then closes. Air flow from the pneumatic duct to the starter is stopped, ending the starting operation.
 - (4) Alternative low pressure start
 - (a) On airplanes incorporating service bulletin No. 1241, a bypass circuit permits starting an engine if the starter cutout switch malfunctions. (See figure 16.) With engine start control switch in the "GROUND START" position hold the alternate low press start switch on, the low pressure air shutoff valve will then be energized to open. Release the engine start control switch and the alternate low press start switch when the engine reaches 33-35% No RPM.

ENGINE No RPM SHOULD BE MONITORED CLOSELY TO PREVENT WARNING: OVERSPEEDING OF STARTER WHEN BYPASS SWITCH IS USED.





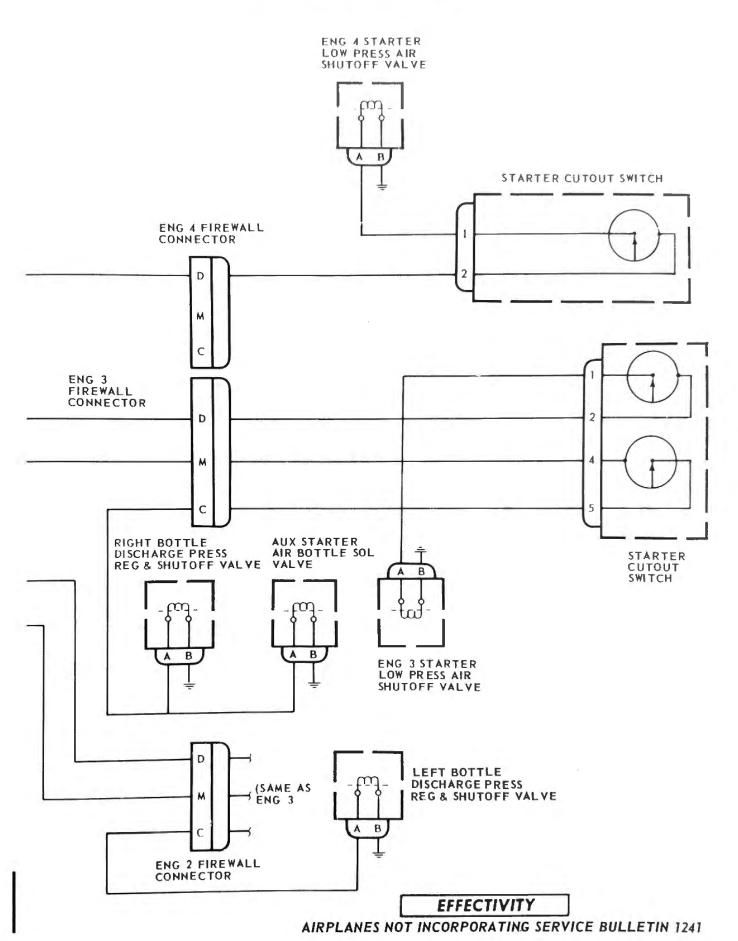
EFFECTIVITY

AIRPLANES NOT INCORPORATING SERVICE BULLETIN 1241

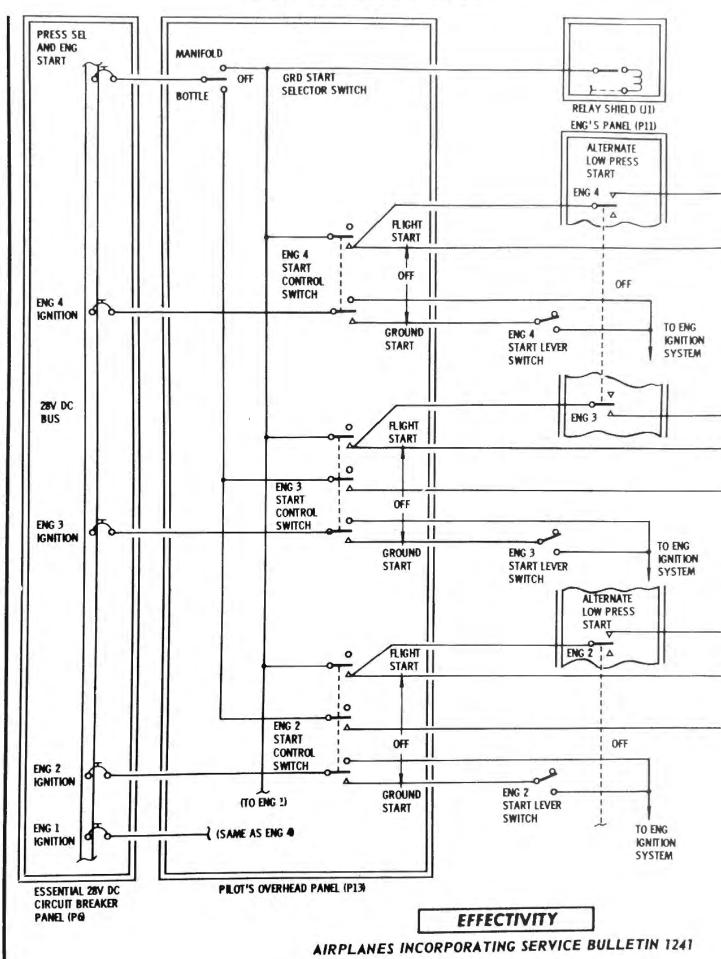
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Revised





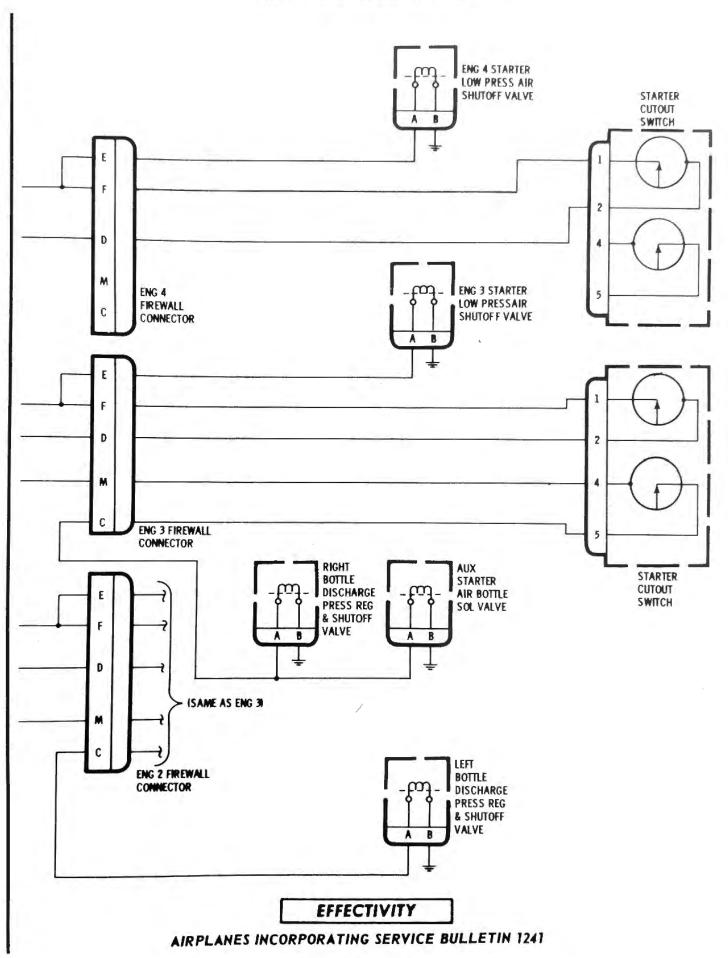




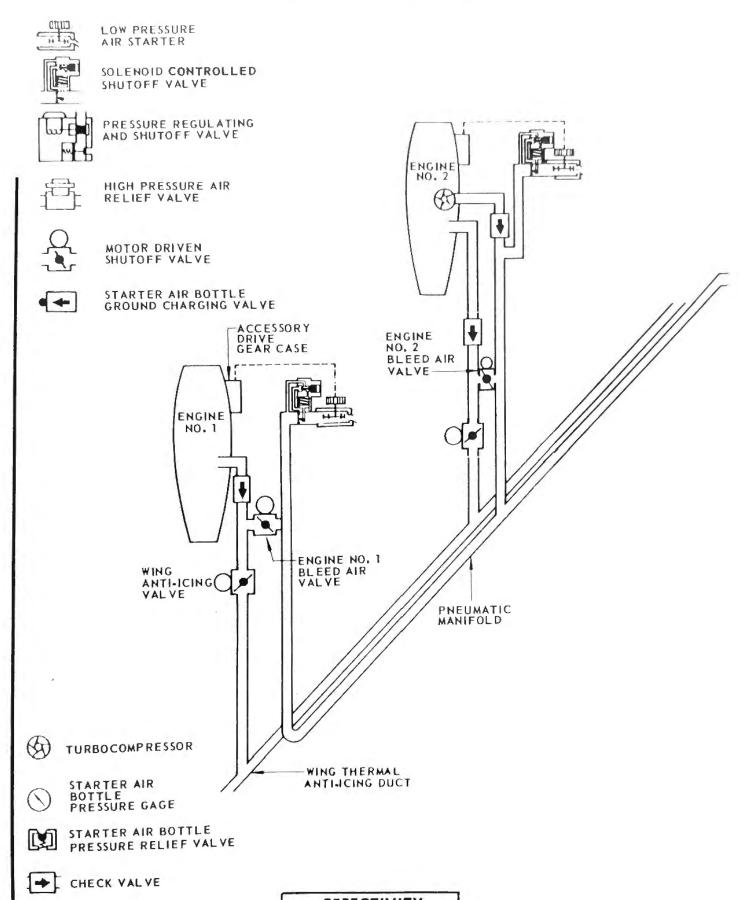
Starting System Circuit Figure 16 (Sheet 3 of 4)

May 15/61 Revised





2 May 15/61 Revised Starting System Circuit Figure 16 (Sheet 4 of 4)

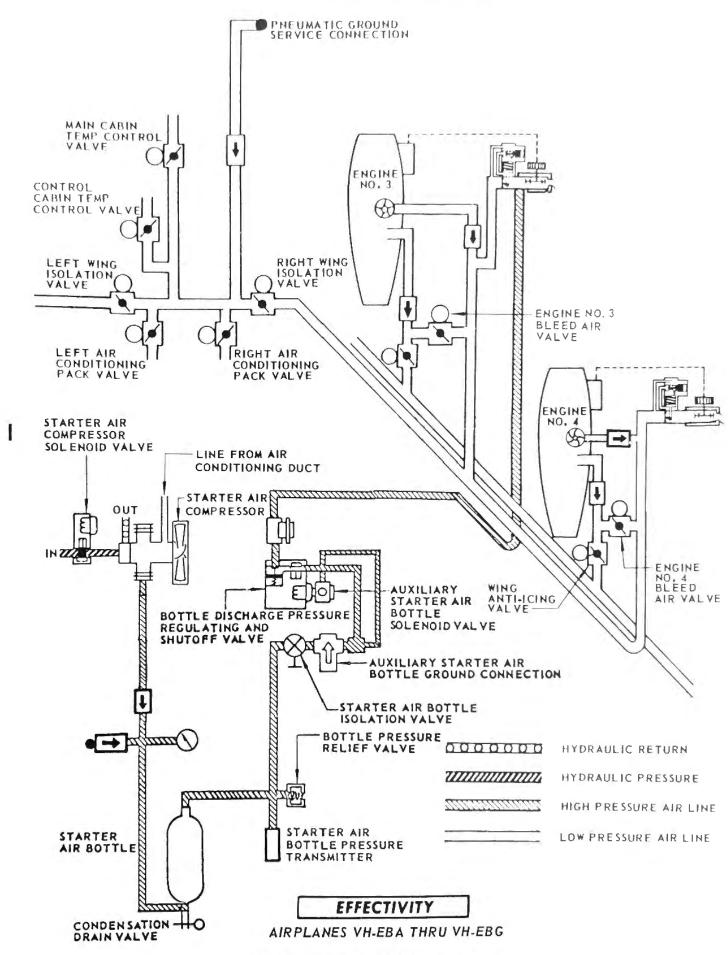


EFFECTIVITY

AIRPLANES VH-EBA THRU VH-EBG

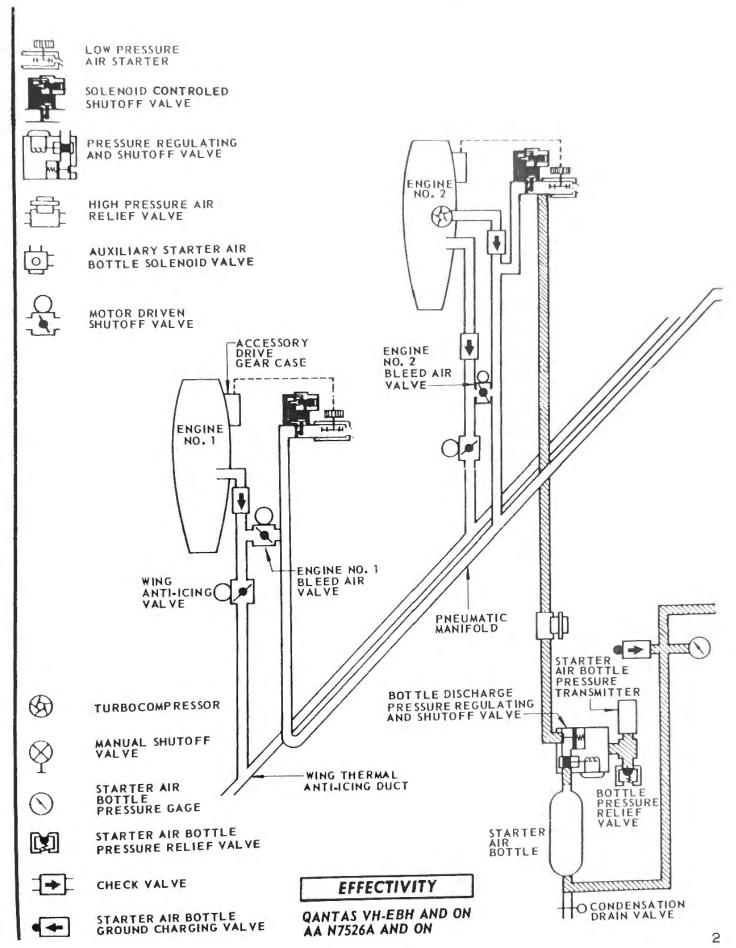
Starting System Flow Diagram Figure 17 (Sheet 1 of 4)





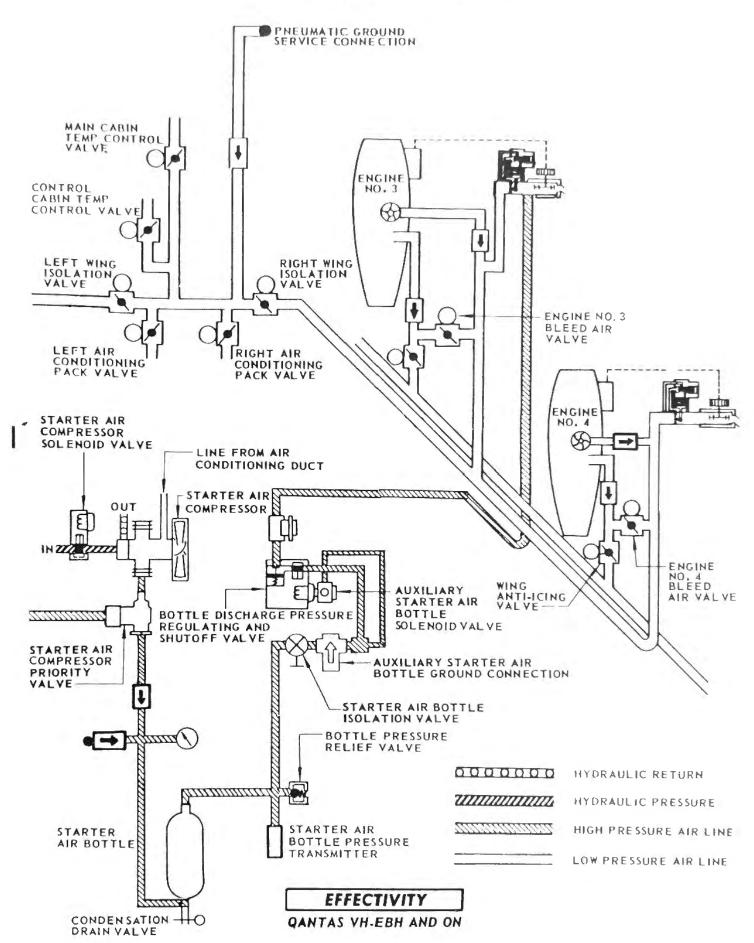
5 Dec 15/61 Revised Starting System Flow Diagram Figure 17 (Sheet 2 of 4)





Starting System Flow Diagram Figure 17 (Sheet 3 of 4)





5 Dec 15/61 Revised Starting System Flow Diagram Figure 17 (Sheet 4 of 4)



E. Low Pressure Start Using Airplane Air Source

- (1) This method of starter operation is also applicable to all engines and is dependent upon having either engine No. 2, 3 or 4 operating, so that turbocompressor output from the operating engine, is directed into the pneumatic manifold. With ground start selector switch in "LOW PRESS" position the turbocompressor flow control valve is energized to operate the turbocompressor at a higher output (ground mode).
- (2) Control and operation are the same as for a low pressure start using external air source.

F. High Pressure Start Using Airplane-Contained Air Source

- (1) This method of starter operation is applicable to engines No. 2 and 3, which are fitted with high pressure starters, and is dependent upon having the starter air bottles charged to 3000 psig. On airplanes VH-EBH and on the left starter air bottle supplies air to engine No. 2 and on all airplanes the right starter air bottle supplies air to engine No. 3. The starter air bottle isolation valve must be in the open position when starting engine No. 3.
- (2) When an engine start control switch is positioned to "GROUND START" and the ground start selector switch is in the "HIGH PRESS" position, 28-volt d-c power is provided through the starter cutout switch to actuate the bottle discharge pressure regulating and shutoff valve. This action also closes the auxiliary starter air bottle solenoid valve when starting engine No. 3. The proper operation of these components causes high pressure air to be directed to the turbine of the high pressure air starter. (See figure 17.)
- (3) If the starter output shaft reaches 2300 to 2500 rpm the cutout switch actuates and interrupts power to the auxiliary starter air bottle solenoid valve and the bottle discharge pressure regulating and shutoff valve terminating the action of these components and thus the starting operation. (See figure 16.)

G. High Pressure Start Using External Air Source

- (1) This method of starter operation is applicable only to engine No. 3, which is fitted with a high pressure starter and is dependent upon having a 3000 psig air supply connected to the auxiliary starter air bottle ground connection. The starter air bottle isolation valve must be maintained in the closed position.
- (2) Control and operation are the same as for the high pressure start using airplane-contained air source.



TURBOFAN



STARTING SYSTEM - TROUBLE SHOOTING

1. Trouble Shooting Low Pressure (Manifold) Start

A. General

(1) The ability of a low pressure air starter to successfully start an engine is dependent upon the airplane pneumatic system being properly pressurized, the external electrical power connected to the airplane, and the engines serviced and in good operating condition. Other procedures preparatory to the initiation of a normal engine start must also be observed.

B. Pneumatic System

(1) A sufficient flow of air must be available from either a low pressure air ground service cart or from an engine driven turbocompressor. To pressurize the pneumatic manifold, the air supplied to the starter must meet the following conditions:

Maximum Air Temperature 475°F
Air Pressure Limits 22 to 46 psig
Minimum Air Delivery at 22 psig 90 lbs/min

- (2) The left and right air conditioning pack shutoff valves must be closed. (See Chapter 21, "Air Conditioning.")
- (3) The left and right wing isolation valves must be open. (See Chapter 36, "Pneumatic System.")

NOTE: Before attempting an engine start, sufficient time should be allowed for movement of the isolation and pack valves to be completed.

C. Electrical

- (1) External electrical power, 115/200 volt, 3-phase, ac, should be supplied to the airplane.
- (2) The applicable circuit breakers must be closed. Refer to 80-1-0, "Test Low Pressure Air Starter."

D. Engine

- (1) The engine inlet must be clear of ice and the engine compressors free to rotate.
- (2) The engine fuel and ignition systems must be operating properly.
- (3) The N₂ tachometer and other engine indicating instruments must be operating correctly.



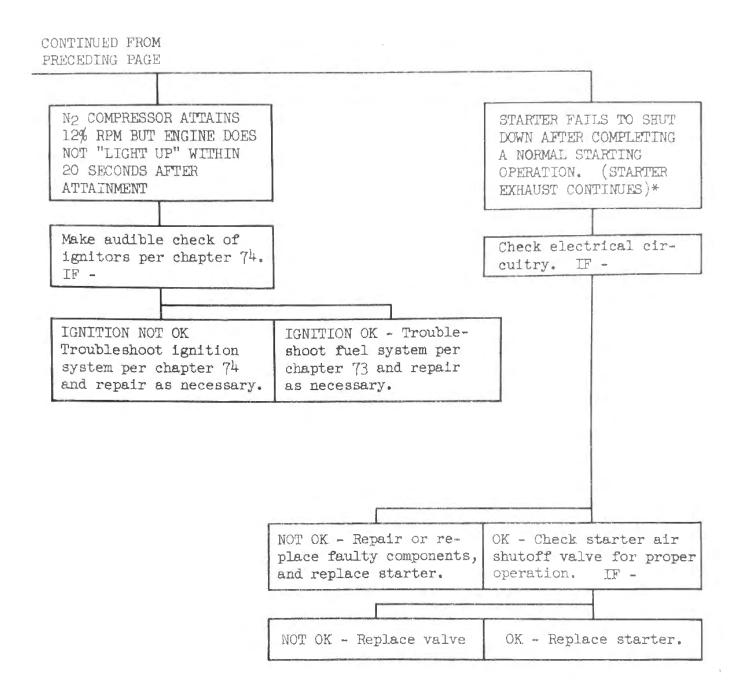
EFFECTIVITY :

2. Low Pressure Starting System Trouble Shooting Chart

With adequate low pressure air supplied, (See 81-1-0) attempt a low pressure start.* IF -No COMPRESSOR DOES NOT ATTAIN 10% RPM WITHIN 8 TO 14 SECONDS * WARNING: IF RPM'S EXCEED 38% ON THE N2 TACHOMETER DURING THESE TESTS, SHUT DOWN THE STARTER Observe starter for ex-AIR SUPPLY IMMEDIATELY. haust air and low pressure air shutoff valve position. VALVE IS CLOSED (NO AIR FLOW) - Remove electrical connector and test for 28V D-C voltage drop from pin A to pin B (B is grounded). IF -28V DC VOLTAGE DROP 28V DC DROP DOES NOT Replace valve. EXISTS. EXIST. Check the circuit segments and repair as necessary. VALVE OPEN (AIR FLOWS FROM EXHAUST) BUT No VALVE OPEN AND STARTER COMPRESSOR ROTATES TOO SLOWLY - Check for OPERATES BUT FAILS TO foreign material in scroll assembly and turbine ROTATE No COMPRESSOR that may be causing binding. NOT OK - Remove foreign OK - Replace starter. material. If No compressor still rotates too slowly, check engine per Check for failed starter Chapter 72. drive shaft. IF -NOT OK - Replace starter OK - Replace starter. drive shaft.



Strateliner MAINTENANCE MANUAL



*CAUTION: THE STARTER MUST BE REPLACED WHEN THIS CONDITION EXISTS, FOR IT IS POSSIBLE THAT THE STARTER TURBINE HAS BEEN STRUCTURALLY DAMAGED BY EXCESSIVE ROTATIONAL SPEED.



STARTING SYSTEM - MAINTENANCE PRACTICES

1. Unit Servicing Starting System

- A. General
 - (1) Servicing of the installed starters is limited to draining and refilling, or adding oil to the lubricating oil sumps.
- B. Service Starter
 - (1) Equipment and Materials
 - (a) Lubricating Oil, MIL-L-7808, or Humble or Esso Turbo Oil TJ-15
 - (2) Drain and refill starter lubricating oil sump.
 - (a) Remove oil fill plug and oil drain plug and allow oil to drain completely. (See figure 2.)

WARNING: PROLONGED CONTACT OF MIL-L-7808 OIL WITH THE SKIN MAY CAUSE DERMATITIS, THE OIL WILL STAIN CLOTHING AND MAY SOFTEN PAINT. SKIN MUST BE THOROUGHLY WASHED AFTER CONTACT AND SATURATED CLOTHING MUST BE REMOVED IMMEDIATELY. PAINTED SURFACES ON WHICH OIL HAS BEEN SPILLED SHOULD BE CLEANED IMMEDIATELY.

- (b) Install oil drain plug and fill starter oil sump with 350 cubic centimeters of lubricating oil. Install oil fill plug.
- (3) Add oil to starter lubricating oil sump.
 - (a) Drain and fill starter oil sump as indicated in paragraph B.(2), using clean lubricating oil removed from starter and adding a sufficient quantity of new recommended oil to make up the total specified amount.

CAUTION: DO NOT USE DRAINED OIL IF CONTAMINATED WITH FOREIGN MATERIAL OR METAL PARTICLES.

SOME OILS ARE NOT COMPATIBLE WHEN MIXED. UNLESS COMPATIBILITY IS ASSURED, DO NOT MIX BRAND NAME OILS.

NOTE: The drained oil may be reused prior to oil change time if it is free of foreign material and metal particles.



2. Adjustment/Test Starting System

A. General

(1) Testing the starting system consists of testing the high/low pressure air starter, and low pressure air shutoff valves.

B. Equipment and Materials

(1) Ground Low Pressure Source, Boeing Turbine Compressor Model 502-11B or equivalent. The following output limits shall apply:

Maximum Air Outlet Temperature 475°F
Maximum Air Outlet Pressure 46 psig
Minimum Delivery at 22 psig 90 lbs/min

(2) Ground electrical power 115/200 volt, 3-phase ac.

C. Test High/Low Pressure Air Starter Using Low Pressure Air

- (1) Ground airplane to an approved grounding lug. Refer to "Static Grounding" Chapter 13.
- (2) On airplanes fitted with rotary type start control switches, check that switches are off.
- (3) Connect external electrical power to airplane.
- (4) Connect external low pressure air source to pneumatic ground service connection.
- (5) Place air conditioning control valve switches to "OFF" position. Air conditioning pack shutoff valves should close. Check external indicator on valves located in air conditioning equipment bay. Refer to Chapter 21, "Air Conditioning."
- (6) Place engine bleed air valve switches to "OFF" position. Refer to Chapter 36, "Pneumatic System."
- (7) Place left and right wing isolation valve switches to "OPEN" position. Check external indicator on valves located in air conditioning distribution bay. Refer to Chapter 36, "Pneumatic System."

<u>NOTE</u>: The wing isolation valves should now be open so that external low pressure air can be directed to the starter low pressure (manifold) air shutoff valves on each engine.



- (8) Continue with normal start procedure, starter should accelerate N2 compressor to 31-35% rpm in 20 seconds. Monitor N2 tachometer indicator while performing this test.
- (9) When N2 tachometer indicator shows 33 to 35% rpm, release engine start control switch to "OFF" position.
 - CAUTION: IF ENGINE START CONTROL SWITCH IS NOT RELEASED WHEN N2 SPEED REACHES 35% RPM, STARTER WILL OVERSPEED AND CAN BE SEVERELY DAMAGED.
- (10) Check duct pressure indicator for sudden rise in pressure, when start switch is released, indicating that starter low pressure air shutoff valve has closed. Check external indicator on valve to verify that valve has closed fully.
- (11) Test other engines in same manner.



TEMPORARY REVISION 80-3

File this temporary revision opposite to 80-1-0, page 202 dated Jun 15/63.

On airplanes VH-EBL and VH-EBM the alternate low pressure start circuit, which bypasses the starter cutout switch, is deactivated and control of the starter air supply is by the engine start control switch. This temporary revision provides the procedure for testing air starters with deactivated cutout switches.

For the above airplanes replace steps C.(8) and C.(9) with the following.

- (8) Continue with normal start procedure, starter should accelerate N2 compressor to 31-35% rpm in 20 seconds. Monitor N2 tachometer indicator while performing this test.
- (9) When N₂ tachometer indicator shows 33 to 35% rpm, release engine start control switch to "OFF" position.
 - CAUTION: IF ENGINE START CONTROL SWITCH IS NOT RELEASED WHEN N2 SPEED REACHES 35% RPM, STARTER WILL OVERSPEED AND MAY BE SEVERELY DAMAGED.
- (10) Check duct pressure indicator for sudden rise in pressure, when start switch is released, indicating that starter low pressure air shutoff valve has closed. Check external indicator on valve to verify that valve has closed fully.
- (11) Test other engines in same manner.



MAINTENANCE MANUAL

- (7) Place engine bleed air valve switches to "OFF" position. Refer to Chapter 36, "Pneumatic System."
- (8) Place left and right wing isolation valve switches to "OPEN" position. Check external indicator on valves located in air conditioning distribution bay. Refer to Chapter 36, "Pneumatic System."
 - The wing isolation valves should now be open so that NOTE: external low pressure air can be directed to the starter low pressure (manifold) air shutoff valves on each engine.
- (9) With external low pressure air supplied to the airplane, place engine start control switch for starter to be tested to "GROUND START." The starter low pressure (manifold) air shutoff valve should open. Check external indicator on valve located adjacent to pneumatic starter.
- (10) Continue with normal start procedure. Starter should motor No compressor to 31 - 35% rpm in approximately 20 seconds.
 - (a) At 34% rpm starter cutout switch should open, causing starter low pressure (manifold) air shutoff valve to close. Check external indicator on valve to verify that valve is closed.
- (11) Test each low pressure air starter in the same manner.

CAUTION: DO NOT EXCEED THE FOLLOWING LOW PRESSURE AIR STARTING CYCLE LIMITATIONS.

- (a) For normal starting the duty cycle is 30 seconds maximum on and 60 seconds off.
- (b) For a slow starting engine the duty cycle may be extended to 60 seconds maximum on, at speeds up to starter cut-out speed and 60 seconds off. This extended duty cycle may be repeated once and then a five minute cooling period must be observed between extended duty cycles.
- (c) For motoring the engine with fuel and ignition off, the duty cycle is two minutes maximum on and five minutes off.
- Test High Pressure Air Starter and Starter Air Compressor D.
 - (1) Ground airplane to an approved grounding lug.



- (2) Supply high pressure air from either an external or airplane source.
 - (a) External source: Connect external high pressure air supply (3000 psig) to auxiliary starter air bottle ground connection.

NOTE: Starter air bottle isolation valve must be in closed position.

- (b) Airplane source: Open starter air bottle isolation valve.
 - NOTE: A fully charged air bottle should be used for each start when checking combustion-pneumatic starter performance.
- (3) Open "PRESS SEL & ENG START" circuit breaker, applicable engine "IGNITION" circuit breaker, and "ENG IGNITORS" circuit breakers located on essential 28-volt dc circuit breaker panel (P6).
- (4) Open "AIR COMPRESSOR TIMER" circuit breaker on 115-volt ac bus No. 3 panel (P3).
- (5) Open "START AIR COMP CONT" circuit breaker on 28-volt dc TR bus No. 3 panel (P5).
- (6) Connect external electrical power to airplane.
- (7) Test starter air compressor.
 - (a) Provide hydraulic power for starter air compressor motor operation.
 - (b) Check that compressor is serviced to proper oil level.
 - (c) Open "LANDING GEAR IND LTS & ANTI-SKID RELAY" circuit breaker, panel (P5).
 - (d) Close "START AIR COMP CONT" circuit breaker, panel (P5).
 - NOTE: If the starter air bottle pressure drops to 2700 psig or less, the compressor will operate to charge the bottle to 3100 (± 100) psig and stop.



- (e) Close "AIR COMPRESSOR TIMER" circuit breaker, panel (P3).
 - NOTE: At approximately 12 minute intervals the timer allows the compressor to cut off for a period of 9 to 15 seconds. This provides a means of blowing moisture out of the air compressor drain line.
- (f) To reduce operation time of the starter air compressor the air bottles may be charged to not more than 2700 psig through the starter air bottle ground charging valves.
- (g) Check for air leakage at all connections and fittings in the starter air bottle charging system. There should be no leakage.
- (8) Close "PRESS SEL & ENG START" circuit breaker, applicable engine "IGNITION" circuit breaker, and "ENG IGNITORS" circuit breakers.
- (9) Place ground start selector switch to "BOTTLE."
- (10) Operate high pressure air starter by placing applicable engine start control switch to "GROUND START."
- (11) Continue with normal start procedure. Starter should motor N₂ compressor to 31-35% rpm in approximately 15 seconds.
 - NOTE: The high pressure air starter should operate through one cycle and shut down. The time required for the starter to raise the N₂ compressor rpm to cutout speed is approximately 15 seconds under normal conditions.
- (12) Test each high pressure air starter in the same manner.
 - CAUTION: DO NOT EXCEED THE FOLLOWING HIGH PRESSURE AIR STARTING CYCLE LIMITATIONS.
 - (a) Time between first and second start 60 seconds.
 - (b) Time between second and third start at least one hour.



PNEUMATIC STARTER - MAINTENANCE PRACTICES

1. Servicing Pneumatic Starter

A. General

(1) After removal from the airplane, the pneumatic starter must be preserved for shipment or storage. It is necessary also, to depreserve a replacement pneumatic starter prior to installation.

WARNING: DO NOT LIFT STARTER BY SPLINED SHAFT. SHAFT IS HELD ONLY BY A SNAP RING AND CAN EASILY SLIP OUT.

B. Preservation of Pneumatic Starter

- (1) Drain all lubricating oil from the starter oil sump by removing the oil fill and drain plugs and allowing starter oil sump to drain completely. (See figure 202.)
- (2) Replace oil drain plug and refill starter oil sump using approximately 150 cubic centimeters of corrosion preventive compound, MIL-C-8188, Grade A. Replace oil fill plug.
- (3) Rotate the starter slowly in all directions so that all internal surfaces are throughly coated with corrosion preventive compound.

 Manually turn the starter output shaft several revolutions in both directions.
- (4) Drain all corrosion preventive compound from the starter by removing the oil fill and drain plugs.
- (5) Replace starter oil fill and drain plugs and tighten securely.
- (6) Cover all openings and connections on the unit with protective plugs or covers and wipe all oil, grease, or dirt from all external surfaces.
- C. Depreservation of Pneumatic Starter

WARNING: A REPLACEMENT STARTER MUST BE DEPRESERVED BEFORE BEING PLACED IN OPERATION.

- (1) Remove oil fill plug and fill starter sump with 350 cubic centimeters of lubricating oil, MIL-L-7808. (See figure 202.)
- (2) Replace oil fill plug and rotate the starter in all directions so that all internal surfaces are thoroughly coated with lubricating oil.



- (3) Remove lubricating oil fill and drain plugs and allow starter oil sump to drain completely. Starter must be held in horizontal position with drain hole down for complete draining.
- (4) Install lubricating oil drain plug and tighten securely.
- (5) Fill starter oil sump with 350 cubic centimeters of oil, MIL-L-7808.

CAUTION: DO NOT FILL STARTER OIL SUMP TO LEVEL OF LUBRICATING OIL PLUG. STARTER OIL SUMP HAS A RECOMMENDED LUBRICATING OIL CAPACITY OF APPROXIMATELY 350 CUBIC CENTIMETERS.

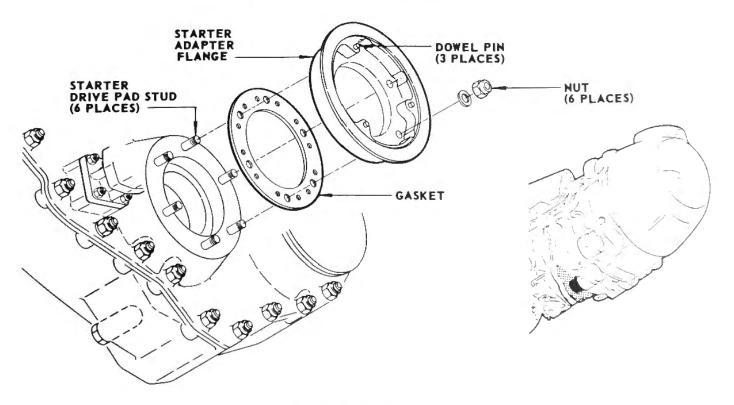
- (6) Install oil fill plug and tighten securely.
- 2. Removal/Installation Pneumatic Starter
 - A. Equipment and Materials
 - (1) Lubricating grease, MIL-L-3545 or equivalent.
 - B. Remove Pneumatic Starter (See figure 202.)
 - (1) Open engine side cowl panels.
 - (2) Disconnect electrical plug from starter.
 - (3) Disconnect electrical plug (2) from starter low pressure (manifold) air shutoff valve.
 - (4) Open clamp (6) holding starter low pressure (manifold) air shutoff valve to starter.
 - (5) Open clamp (1) holding starter low pressure (manifold) air shutoff valve to low pressure pneumatic duct and remove shutoff valve.
 - (6) Open clamp (3) attaching starter exhaust duct to starter.
 - (7) Open clamp (7) attaching pneumatic starter to starter adapter flange and remove starter from engine.

NOTE: If for any reason the starter adapter flange must be removed from the accessory drive pad remove six nuts and washers holding adapter flange to pad. (See figure 201.)

- C. Install Pneumatic Starter (See figures 201 and 202.)
 - (1) Remove all shipping plugs, covers and caps from the starter.
 - (2) Install gasket on engine starter pad of the accessory drive gear case before attaching starter adapter flange. (See figure 201.)

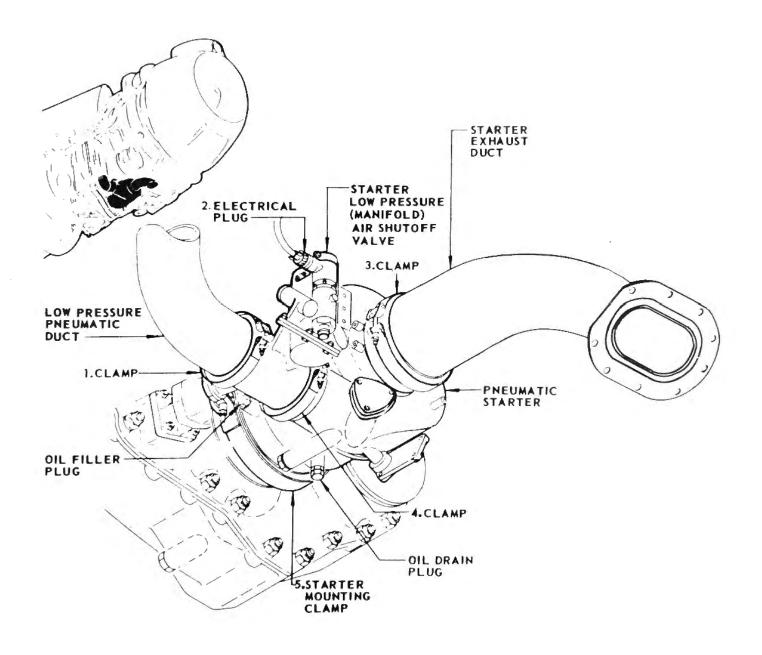
- (3) Position the starter adapter flange with one of the dowel pins between the bottom two studs and attach flange to accessory drive gear case with six nuts and washers and tighten securely. (See figure 201.)
- (4) Determine a position for the starter, in relation to the engine drive gear case, which will position the oil drain plug at the lowest possible point and still provide accessibility to the electrical receptacle and either of the two fill plugs. (See figure 202.)
- (5) Determine whether the scroll assembly will have to be reoriented on the housing assembly to align the inlet connection with the low pressure pneumatic duct.
 - NOTE: The scroll assembly may be rotated about the axis of the starter to any position necessary to facilitate connection to the low pressure pneumatic duct.
- (6) If reorientation of the scroll assembly is necessary, loosen the eight nuts securing the scroll clamping flange to the housing assembly, rotate the scroll assembly as necessary and retighten nuts to a torque of 35 to 45 pound-inches. (See figure 2, 80-0.)
- (7) Lubricate starter output shaft splines with lubricant MIL-L-3545 and attach starter to the flange using starter mounting clamp. (See figure 202.) Tighten nut to torque of 40 to 50 pound-inches.

CAUTION: MAKE CERTAIN THAT SPLINES OF THE STARTER OUTPUT SHAFT ARE PROPERLY ENGAGED WITH THE COUPLING IN THE ENGINE DRIVE PAD.





- (8) Connect starter exhaust duct to starter exhaust outlet with clamp (3).
- (9) Deleted
- (10) Connect electrical plug to receptacle on starter.
- (11) Install starter low pressure (manifold) air shutoff valve. Refer to "Install Starter Low Pressure (Manifold) Air Shutoff Valve", 80-2-11.
- (12) Test operation of installed starter. Refer to "Test pneumatic starter", 80-0.



LOW PRESSURE AIR STARTER - MAINTENANCE PRACTICES

EFFECTIVITY

AA 707-123B AND QANTAS 707-138B

1. Unit Servicing Low Pressure Air Starter

A. General

(1) After removal from the airplane, the low pressure air starter must be preserved for shipment or storage. It is necessary also, to depreserve a replacement low pressure air starter prior to installation.

WARNING: DO NOT LIFT STARTER BY SPLINED SHAFT. SHAFT IS HELD ONLY BY A SNAP RING AND CAN EASILY SLIP OUT.

B. Preservation of Low Pressure Air Starter

- (1) Drain all lubricating oil from the starter oil sump by removing the oil fill and drain plugs and allowing starter oil sump to drain completely. (See figure 202.)
- (2) Install oil drain plug and refill starter oil sump using approximately 150 cubic centimeters of corrosion preventive compound, MIL-C-8188, Grade A. Install oil fill plug.
- (3) Rotate the starter slowly in all directions so that all internal surfaces are thoroughly coated with corrosion preventive compound.

 Manually turn the starter output shaft several revolutions in both directions.
- (4) Drain all corrosion preventive compound from the starter by removing the oil fill and drain plugs.
- (5) Install starter oil fill and drain plugs.
- (6) Cover all openings and connections on the unit with protective plugs or covers and wipe all oil, grease, or dirt from all external surfaces.
- C. Depreservation of Low Pressure Air Starter

WARNING: A REPLACEMENT STARTER MUST BE DEPRESERVED BEFORE BEING PLACED IN OPERATION.

(1) Remove oil fill plug and fill starter sump with 350 cubic centimeters of lubricating oil, MIL-L-7808. (See figure 202.)



MAINTENANCE MANUAL

- (2) Install oil fill plug and rotate the starter in all directions so that all internal surfaces are thoroughly coated with lubricating oil.
- (3) Remove lubricating oil fill and drain plugs and allow starter oil sump to drain completely. Starter must be held in horizontal position with drain hole down for complete draining.
- (4) Install lubricating oil drain plug.
- (5) Fill starter oil sump with 350 cubic centimeters of oil, MIL-L-7808.

CAUTION: DO NOT FILL STARTER OIL SUMP TO LEVEL OF LUBRICATING OIL PLUG. STARTER OIL SUMP HAS A RECOMMENDED LUBRICATING OIL CAPACITY OF APPROXIMATELY 350 CUBIC CENTIMETERS.

(6) Install oil fill plug.

2. Removal/Installation Low Pressure Air Starter

- A. Equipment and Materials
 - (1) Lubricating grease, MIL-L-3545 or equivalent.
- B. Remove Low Pressure Air Starter (See figure 202.)
 - (1) Open engine side cowl panels.
 - (2) Disconnect electrical plug from starter.
 - (3) Open clamp holding starter to low pressure pneumatic duct.
 - (4) Open starter mounting clamp attaching low pressure air starter to starter adapter flange and remove starter from engine.

NOTE: If for any reason the starter adapter flange must be removed from the accessory drive pad remove six nuts and washers holding adapter flange to pad. (See figure 201.)

- C. Install Low Pressure Air, Starter (See figures 201 and 202.)
 - (1) Remove all shipping plugs, covers and caps from the starter.
 - (2) Install gasket on engine starter pad of the accessory drive gear case before attaching starter adapter flange. (See figure 201.)
 - (3) Position the starter adapter flange with one of the dowel pins between the bottom two studs and attach flange to accessory drive gear case with six nuts and washers and tighten securely. (See figure 201.)

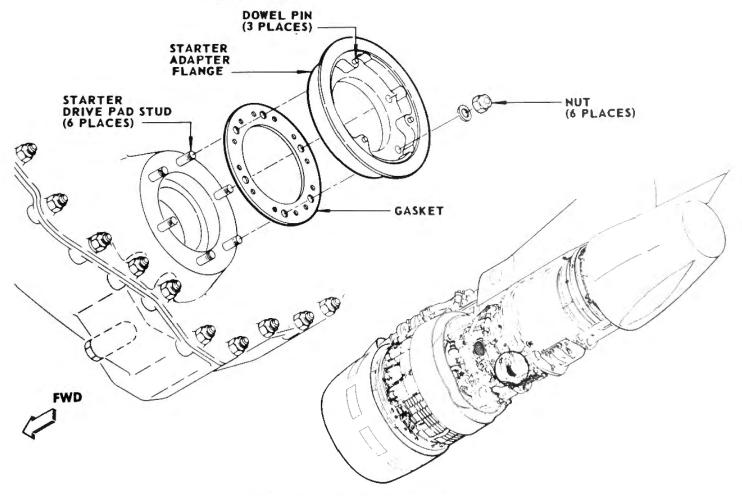


- (4) Determine a position for the starter, in relation to the engine drive gear case, which will position the oil drain plug at the lowest possible point and still provide accessibility to the electrical receptacle and either of the two fill plugs. (See figure 202.)
- (5) Determine whether the scroll assembly will have to be reoriented on the housing assembly to align the inlet connection with the low pressure pneumatic duct.

NOTE: The scroll assembly may be rotated about the axis of the starter to any position necessary to facilitate connection to the low pressure pneumatic duct.

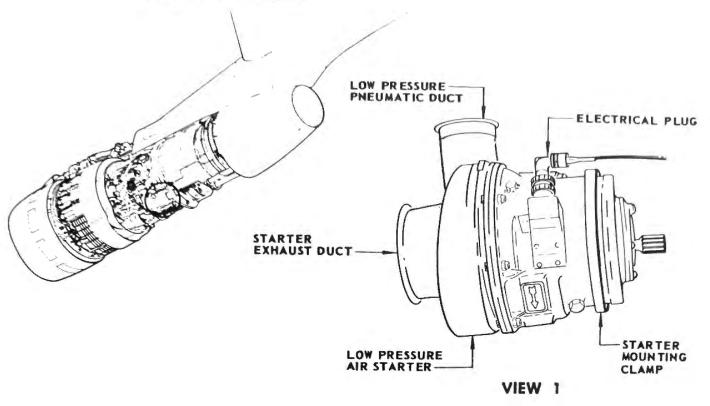
- (6) If reorientation of the scroll assembly is necessary, loosen the eight nuts securing the scroll clamping flange to the housing assembly, rotate the scroll assembly as necessary and retighten nuts to a torque of 35 to 45 pound-inches. (See figure 2, 80-1-0.)
- (7) Coat starter output shaft splines with lubricant, MIL-L-3545 and attach starter to the flange using starter mounting clamp. (See figure 202.) Tighten nut to torque of 40 to 50 pound-inches.

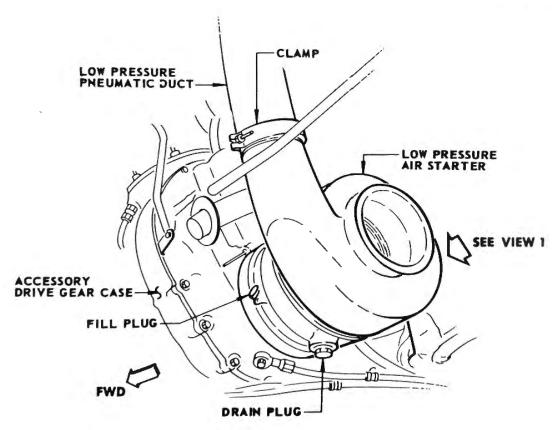
CAUTION: MAKE CERTAIN THAT SPLINES OF THE STARTER OUTPUT SHAFT ARE PROPERLY ENGAGED WITH THE COUPLING IN THE ENGINE DRIVE PAD.





- (8) Connect electrical plug to receptacle on starter.
- (9) Test operation of installed starter. Refer to 80-1-0 "Test low Pressure Air Starter".



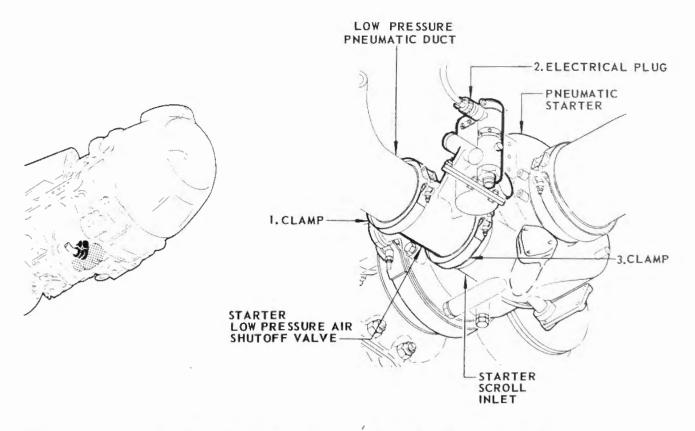




STARTER LOW PRESSURE AIR SHUTOFF VALVE - MAINTENANCE PRACTICES

- 1. Removal/Installation Starter Low Pressure Air Shutoff Valve
 - A. Remove Starter Low Pressure Air Shutoff Valve (See figure 201.)
 - (1) Open right side cowl panel.
 - (2) Disconnect electrical plug (2).
 - (3) Open clamp (3) holding starter low pressure air shutoff valve to starter scroll inlet flange.
 - (4) Open clamp (1) joining starter low pressure air shutoff valve to low pressure pneumatic duct and remove valve.
 - B. Install Starter Low Pressure Air Shutoff Valve (See figure 201.)
 - (1) Connect starter low pressure air shutoff valve to starter scroll inlet with clamp (3).

NOTE: Position starter low pressure air shutoff valve so that arrow on housing is pointed towards starter scroll and electrical receptacle is up.





- (2) Connect low pressure pneumatic duct to starter low pressure air shutoff valve with clamp (1).
- (3) Connect electrical plug (2) to electrical receptacle on starter low pressure air shutoff valve.
- (4) With left side cowl panel open, close right side cowl panel slowly and note any interference between valve, clamps and cowl. If interference exists, change position of units.

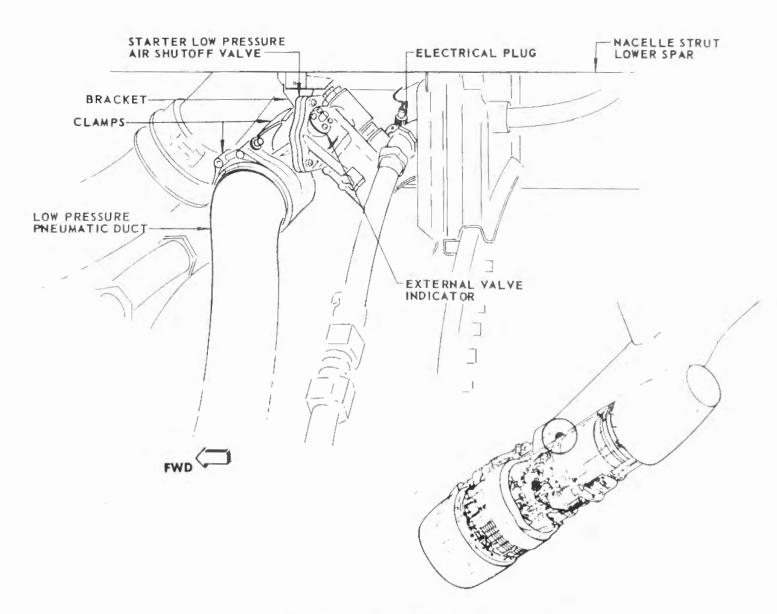
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STARTER LOW PRESSURE AIR SHUTOFF VALVE - MAINTENANCE PRACTICES

- 1. Removal/Installation Starter Low Pressure Air Shutoff Valve
 - A. Remove Starter Low Pressure Air Shutoff Valve (See figure 201.)
 - (1) Open left side cowl panel.
 - (2) Disconnect electrical plug.
 - (3) Remove bolts holding valve to bracket.
 - (4) Open clamps holding starter low pressure air shutoff valve to low pressure pneumatic duct.
 - (5) Remove valve.







- B. Install Starter Low Pressure Air Shutoff Valve (See figure 201.)
 - (1) Prior to valve installation examine valve to ascertain that butterfly is in the closed position.
 - (2) Connect starter low pressure air shutoff valve to low pressure pneumatic duct with clamps.

NOTE: Position starter low pressure air shutoff valve so that arrow on housing is pointing towards starter and electrical receptacle is up.

- (3) Install bolts holding valve to bracket.
- (4) Connect electrical plug to electrical receptacle on starter manifold air shutoff valve.
- (5) Check external valve indicator to insure that valve is in the closed position.
- (6) Close left side cowl panel.



COMBUSTION-PNEUMATIC STARTER - MAINTENANCE PRACTICES

1. Servicing Combustion-Pneumatic Starter

A. General

(1) After removal from the airplane, the combustion-pneumatic starter must be preserved for shipment or storage. It is necessary also, to depreserve a replacement combustion-pneumatic starter prior to installation.

WARNING: DO NOT LIFT COMBUSTION-PNEUMATIC STARTER BY SPLINED SHAFT. SHAFT IS HELD ONLY BY A SNAP RING AND CAN EASILY PULL OUT.

- B. Preservation of Combustion-Pneumatic Starter
 - (1) Drain all lubricating oil from the starter oil sump by removing the oil fill and drain plugs and allowing starter oil sump to drain completely. (See figure 202.)
 - (2) Replace oil drain plug and refill starter oil sump using approximately 150 cubic centimeters of corrosion preventive compound, MIL-C-8188, Grade A. Replace oil fill plug.
 - (3) Rotate the starter slowly in all directions so that all internal surfaces are thoroughly coated with corrosion preventive compound. Manually turn the starter output shaft several revolutions in both directions.
 - (4) Drain all corrosion preventive compound from the starter by removing the oil fill and drain plugs.
 - (5) Replace starter oil fill and drain plugs, and tighten securely.
 - (6) Cover all openings and connections on the unit with protective plugs or covers and Wipe all oil, grease, or dirt from all external surfaces.
- C. Depreservation of Combustion-Pneumatic Starter

CAUTION: A REPLACEMENT STARTER MUST BE DEPRESERVED BEFORE BEING PLACED IN OPERATION.

- (1) Remove oil fill plug and fill starter sump with oil, MIL-L-7808. (See figure 202.)
- (2) Replace oil fill plug and rotate the starter in all directions so that all internal surfaces are thoroughly coated with oil.



- (3) Remove oil fill and drain plugs and allow starter oil sump to drain completely. Starter must be held in horizontal position with drain hole down for complete draining.
- (4) Install oil drain plug and tighten securely.
- (5) Fill starter oil sump with 350 cubic centimeters of oil, MIL-L-7808.

CAUTION: DO NOT FILL STARTER OIL SUMP TO LEVEL OF OIL FILL PLUG. STARTER OIL SUMP HAS A RECOMMENDED LUBRICATING OIL CAPACITY OF APPROXIMATELY 350 CUBIC CENTIMETERS.

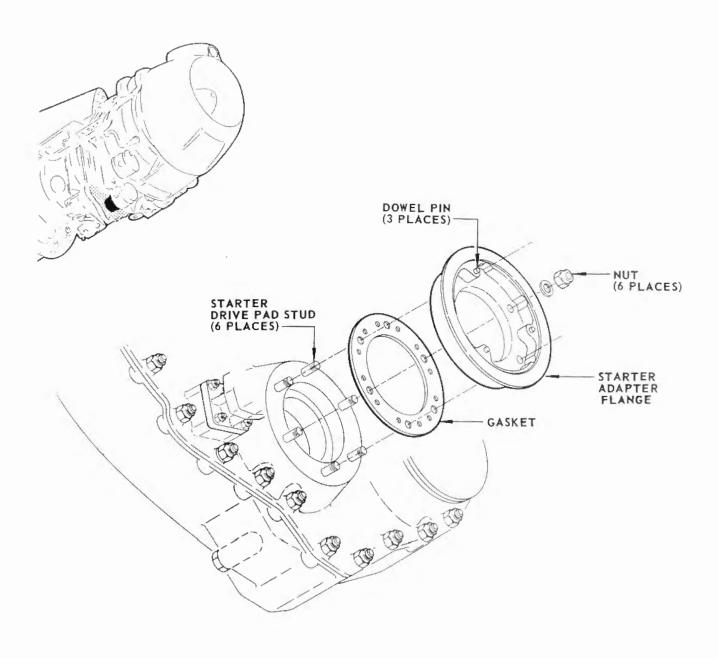
- (6) Install oil fill plug and tighten securely.
- 2. Removal/Installation Combustion/Pneumatic Starter
 - A. Equipment and Materials
 - (1) Lubricating grease MIL-L-3545 or equivalent.
 - B. Remove Combustion-Pneumatic Starter (See figure 202.)
 - (1) Open engine cowl side panels.
 - (2) Disconnect starter electrical plugs from starter.
 - (3) Disconnect electrical plug (2) from starter low pressure (manifold) air shutoff valve.
 - (4) Disconnect high pressure air inlet line (3).
 - (5) Disconnect accumulator fuel inlet line (6).
 - (6) Open clamp (4) holding starter low pressure (manifold) air shutoff valve to starter.
 - (7) Open clamp (1) holding starter low pressure (manifold) air shutoff valve to pneumatic low pressure air duct and remove valve.
 - (8) Open clamp (7) attaching starter exhaust duct to starter.
 - (9) Open clamp (5) attaching starter to starter adapter flange and remove starter from engine accessory drive gear case.

NOTE: If for any reason the starter adapter flange must be removed from the accessory drive gear case, remove six mounting nuts, and washers holding adapter flange to gear case. (See figure 201.)

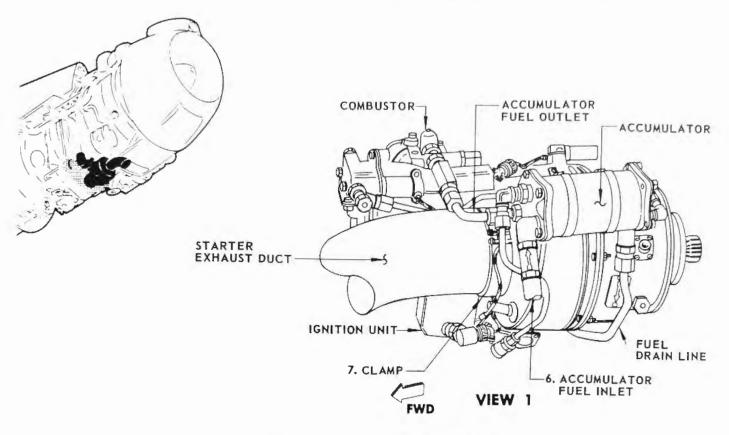
- C. Install Combustion-Pneumatic Starter (See figures 201 and 202.)
 - (1) Remove all shipping plugs, covers and caps from the starter.
 - (2) Install gasket on engine starter pad of the accessory drive gear case before attaching starter adapter flange. (See figure 201.)

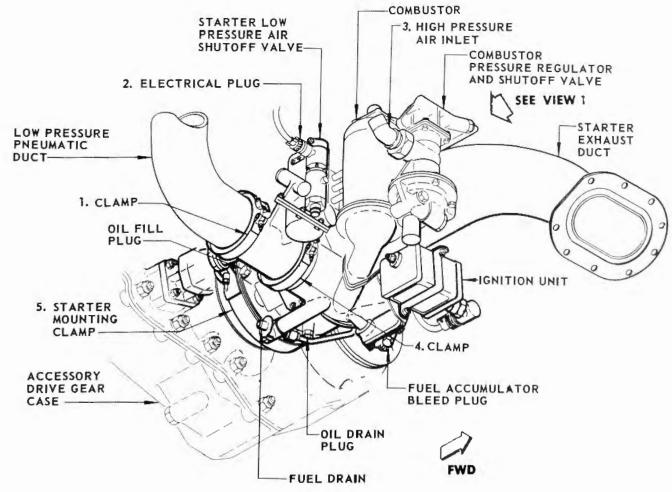


- (3) Position the starter adapter flange with one of the dowel pins between the bottom two studs and attach flange to accessory drive gear case with six nuts and washers and tighten securely. (See figure 201.)
- (4) Determine a position for the starter in relation to the engine drive gear case, which will position the oil drain plug at the lowest possible point and still provide accessibility to the electrical connections and either of the two oil fill plugs. (See figure 202.)











- (5) Coat starter output shaft splines with lubricant, MIL-L-3545 and attach starter to the adapter flarge using starter mounting clamp (5). Tighten nut to torque of 40-50 pound-inches.
 - CAUTION: MAKE CERTAIN THAT SPLINES OF THE STARTER OUTPUT SHAFT ARE PROPERLY ENGAGED WITH THE COUPLING IN THE ENGINE ACCESSORY DRIVE GEAR CASE.
- (6) Connect starter exhaust duct to starter exhaust outlet with clamp (7).
- (7) Connect fuel line to accumulator fuel inlet (6).
- (8) Connect air line to high pressure air inlet (3).
- (9) Connect electrical connections on starter unit.
- (10) Install starter low pressure air shutoff valve. Refer to "Install Starter Low Pressure Air Shutoff Valve," 80-2-11.
- (11) Test operation of combustion-pneumatic starter. Refer to "Test Combustion-Pneumatic Starter," 80-0.



Stratoliner
MAINTENANCE MANUAL

HIGH/LOW PRESSURE AIR STARTER - MAINTENANCE PRACTICES

1. Unit Servicing High/Low Pressure Air Starter

A. General

(1) After removal from the airplane, the high/low pressure air starter must be preserved for shipment or storage. It is necessary also, to depreserve a replacement starter prior to installation.

WARNING: DO NOT LIFT STARTER BY SPLINED SHAFT. SHAFT IS HELD ONLY BY A SNAP RING AND CAN EASILY PULL OUT.

- B. Equipment and Materials
 - (1) Lubricating oil, MIL-L-7808, or Humble or Esso Turbo Oil TJ-15
 - (2) Corrosion preventive compound, MIL-C-8188, Grade A
- C. Preservation of High/Low Pressure Air Starter
 - (1) Drain all lubricating oil from the starter oil sump by removing the oil fill and drain plugs and allowing starter oil sump to drain completely. (See figure 202.)
 - (2) Install oil drain plug and refill starter oil sump using approximately 150 cubic centimeters of corrosion preventive compound, MIL-C-8188, Grade A. Install oil fill plug.
 - (3) Rotate the starter slowly in all directions so that all internal surfaces are thoroughly coated with corrosion preventive compound. Manually turn the starter output shaft several revolutions in both directions.
 - (4) Drain all corrosion preventive compound from the starter by removing the oil fill and drain plugs.
 - (5) Install starter oil fill and drain plugs.
 - (6) Cover all openings and connections on the unit with protective plugs or covers and wipe all oil, grease, or dirt from all external surfaces.





D. Depreservation of High/Low Pressure Air Starter

<u>CAUTION</u>: A REPLACEMENT STARTER MUST BE DEPRESERVED BEFORE BEING PLACED IN OPERATION.

(1) Remove oil fill plug and fill starter sump with lubricating oil. (See figure 202.)

WARNING: PROLONGED CONTACT OF MIL-L-7808 OIL WITH THE SKIN MAY CAUSE DERMATITIS, THE OIL WILL STAIN CLOTHING AND MAY SOFTEN PAINT. SKIN MUST BE THOROUGHLY WASHED AFTER CONTACT AND SATURATED CLOTHING MUST BE REMOVED IMMEDIATELY. PAINTED SURFACES ON WHICH OIL HAS BEEN SPILLED SHOULD BE CLEANED IMMEDIATELY.

- (2) Install oil fill plug and rotate starter in all directions so that all internal surfaces are thoroughly coated with oil.
- (3) Remove oil fill and drain plugs and allow starter oil sump to drain completely. Starter must be held in horizontal position with drain hole down for complete draining.
- (4) Install oil drain plug.
- (5) Fill starter oil sump with 350 cubic centimeters of lubricating oil.

CAUTION: SOME OILS ARE NOT COMPATIBLE WHEN MIXED. UNLESS COMPATIBILITY IS ASSURED, DO NOT MIX BRAND NAME OILS. DO NOT REFILL STARTER OIL SUMP WITH OIL USED TO FLUSH OUT THE CORROSION PREVENTIVE COMPOUND.

DO NOT FILL STARTER OIL SUMP TO LEVEL OF OIL FILL PLUG. STARTER OIL SUMP HAS A RECOMMENDED LUBRICATING OIL CAPACITY OF APPROXIMATELY 350 CUBIC CENTIMETERS.

- (6) Install oil fill plug.
- 2. Removal/Installation High/Low Pressure Air Starter
 - A. Equipment and Materials
 - (1) Lubricating grease, ML-L-3545 or equivalent
 - B. Remove High/Low Pressure Air Starter (See figure 202.)
 - (1) Open engine cowl side panels.
 - (2) Disconnect starter electrical plug from starter.



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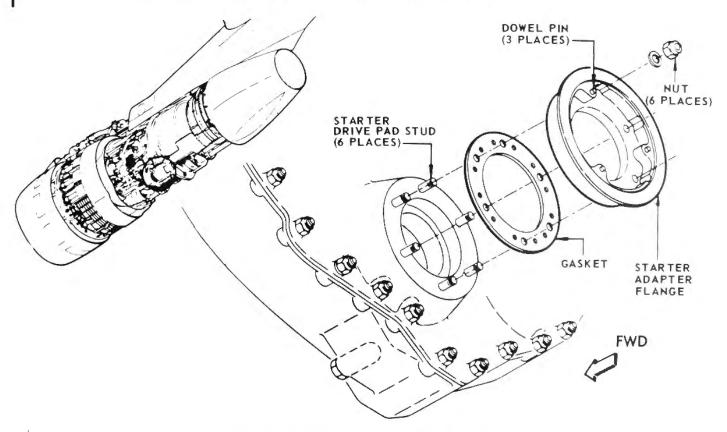


- (3) Disconnect high pressure air inlet line.
- (4) Loosen clamp connecting low pressure air inlet port to low pressure pneumatic duct.
- (5) Open clamp attaching starter to starter adapter flange and remove starter from engine accessory drive gear case.

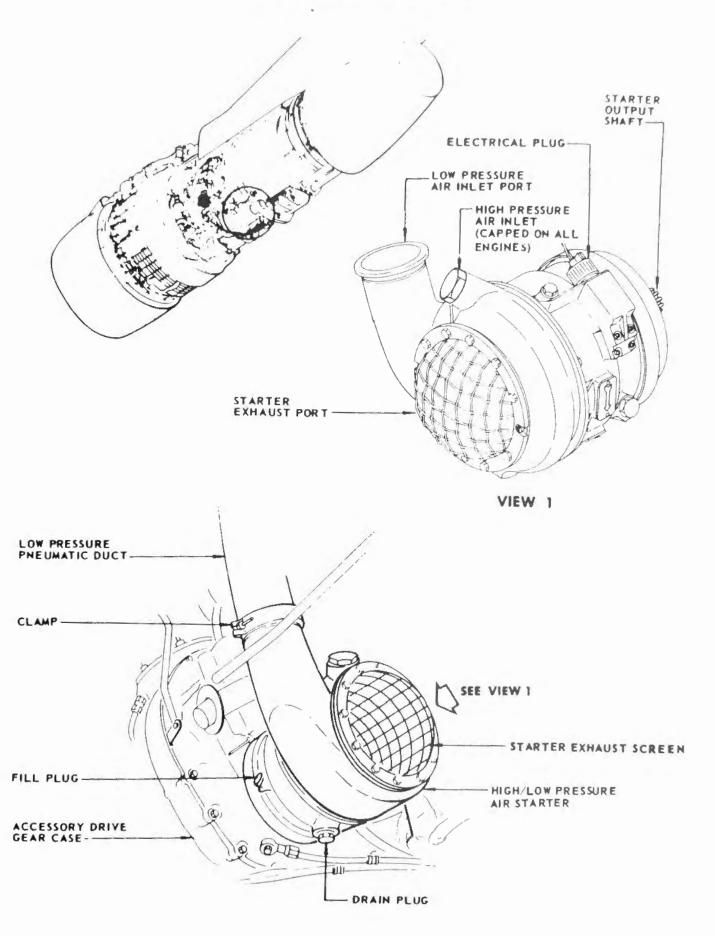
WARNING: DO NOT LIFT STARTER BY SPLINED SHAFT. SHAFT IS HELD ONLY BY A SNAP RING AND CAN EASILY PULL OUT.

- (6) If adapter flange is to be removed from the accessory drive gear case, remove six mounting nuts and washers holding adapter flange to gear case. (See figure 201.)
- C. Install High/Low Pressure Air Starter (See figures 201 and 202.)
 - (1) Remove all shipping plugs, covers, and caps from the starter.
 - (2) Install gasket on engine starter pad of the accessory drive gear case before attaching starter adapter flange. (See figure 201.)
 - (3) Position the starter adapter flange with one of the dowel pins between the bottom two studs and attach flange to accessory drive gear case with six nuts and washers and tighten securely. (See figure 201.)

WARNING: DO NOT LIFT STARTER BY SPLINED SHAFT. SHAFT IS HELD ONLY BY A SNAP RING AND CAN EASILY PULL OUT.









- (4) Determine a position for the starter in relation to the engine drive gear case, which will position the oil drain plug at the lowest possible point and still provide accessibility to the electrical connections and either of the two oil fill plugs. (See figure 202.)
- (5) Coat starter output shaft splines with lubricant, MIL-L-3545 and attach starter to the adapter flange using starter mounting clamp. Tighten nut to torque of 40-50 pound-inches.

CAUTION: MAKE CERTAIN THAT SPLINES OF THE STARTER OUTPUT SHAFT ARE PROPERLY ENGAGED WITH THE COUPLING IN THE ENGINE ACCESSORY DRIVE GEAR CASE.

- (6) Clamp low pressure pneumatic duct to low pressure air inlet port.
- (7) Connect air line to high pressure air inlet.
- (8) Connect electrical plug on starter unit.
- (9) Test operation of high pressure air starter. Refer to 80-1-0, "Test High/Low Pressure Air Starter."

STARTER AIR BOTTLE - MAINTENANCE PRACTICES

1. Unit Servicing Starter Air Bottle

- A. General
 - (1) Unit servicing of the starter air bottle is limited to the periodic draining of accumulated moisture.
- B. Drain Starter Air Bottle (See figure 201.)
 - (1) Remove access panel R161 in aft wing-fuselage fairing. Refer to Chapter 12, "Access Doors and Panels."
 - (2) Slowly open drain valve by turning nut counterclockwise to a maximum of 2 turns.

WARNING: DO NOT LOOSEN DRAIN VALVE MORE THAN 2 TURNS. VALVE MAY BE BLOWN FROM BOTTLE.

KEEP FACE AND HANDS FROM VALVE OPENING. AIR AND WATER ARE EXPELLED WITH CONSIDERABLE FORCE.

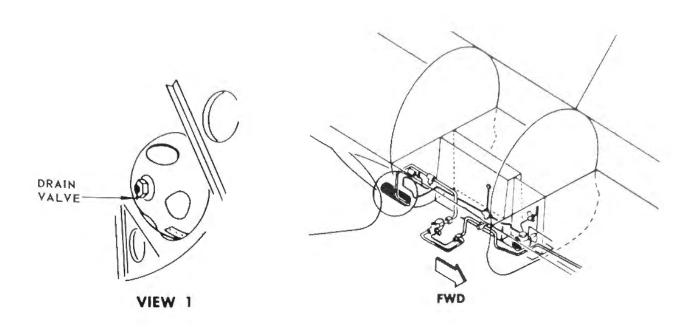
- (3) After water has been drained, close valve and tighten nut to a torque of 80 pound-inches.
- (4) Replace access panel.

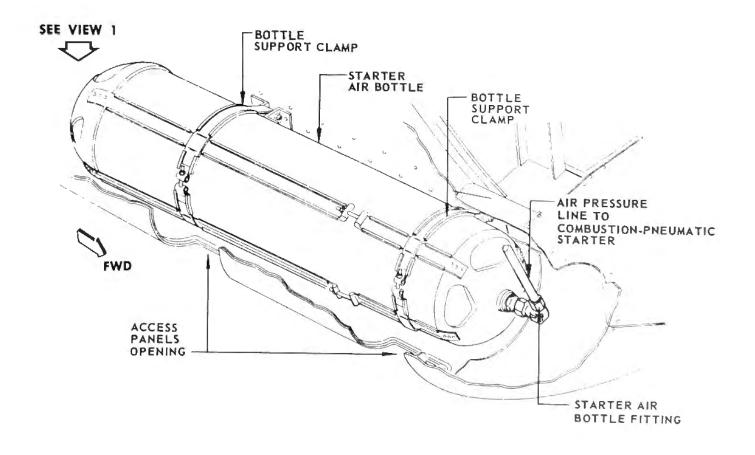
2. Removal/Installation Starter Air Bottle

- A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
- B. Remove Starter Air Bottle (See figure 201.)
 - (1) Open right main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Remove starter air bottle fitting access panel 42. Refer to Chapter 12, "Access Doors and Panels."



- (4) Discharge high pressure air from starter air bottle by removing cap from right ground charging valve and slowly turning hex nut counterclockwise.
- (5) Disconnect high pressure air line at fitting on forward end of starter air bottle.
- (6) Remove air bottle support access panels R177 and R160.
- (7) Loosen the two bottle support clamps and remove bottle through forward access opening.
- (8) Plug air lines unless a new bottle is to be immediately installed.
- C. Install Starter Air Bottle (See figure 201.)
 - (1) Slip starter air bottle into two bottle support clamps and position air bottle so that ports on valves and fittings line up with air lines.
 - (2) Tighten support clamps until bottle is held in position.
 - NOTE: Do not apply final torque on clamp bolts. Bottle may have to be repositioned.
 - (3) Remove plugs from air lines and connect high pressure air line at fitting on forward end of starter air bottle. Reposition bottle as necessary to make connections.
 - (4) Tighten bottle support clamps, bolts and torque nuts from 20 to 30 pound-inches.
 - NOTE: When making a check of torque on a bottle charged to 3000 psig the bottle support clamp nuts should be torqued from 50 to 70 pound-inches.
 - (5) Recharge starter air bottle. Refer to Chapter 12, "Air and Nitrogen Servicing."
 - (6) Check lines for leaks under pressure.
 - (7) Replace access panels 42, R177 and R160.
 - (8) Remove main landing gear door down lock.
 - (9) Close right main landing gear wheel well door.







STARTER AIR BOTTLE - MAINTENANCE PRACTICES

EFFECTIVITY

AA 707-123B QANTAS 707-138B

1. Unit Servicing Starter Air Bottle

- A. General
 - (1) Servicing of the starter air bottle is limited to the periodic draining of accumulated moisture.
- B. Drain Starter Air Bottle
 - (1) Remove access panel R161 or L161 in aft wing-fuselage fairing. Refer to Chapter 12, "Access Doors and Panels."
 - (2) Slowly open drain valve by turning counterclockwise to a maximum of 2 turns.

WARNING: DO NOT LOOSEN DRAIN VALVE MORE THAN 2 TURNS. VALVE MAY BE BLOWN FROM BOTTLE.

KEEP FACE AND HANDS FROM VALVE OPENING. AIR AND WATER ARE EXPELLED WITH CONSIDERABLE FORCE.

- (3) After water has been drained, close valve and tighten nut to a torque of 80 pound-inches.
- (4) Install access panel.

2. Removal/Installation Right Starter Air Bottle

- A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
- B. Remove Right Starter Air Bottle (See figure 201.)
 - (1) Open right main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Remove starter air bottle fitting access panel 42. Refer to Chapter 12, "Access Doors and Panels."
 - (4) Discharge high pressure air from starter air bottle by removing cap from right ground charging valve and slowly turning hex nut counterclockwise.



- (5) On all QANTAS airplanes and on AA airplanes N7526A and on, disconnect high pressure air line from forward end of starter air bottle.
- (6) On AA airplanes N7501A through N7525A, proceed as follows:
 - (a) Open "HIGH PRESS REG VALVE HTR" circuit breaker on 115V a-c bus No. 2 panel (P2) if airplane a-c electrical system is in operation.

CAUTION: BEFORE REMOVING VALVE ASCERTAIN VALVE IS NOT TOO HOT TO HANDLE.

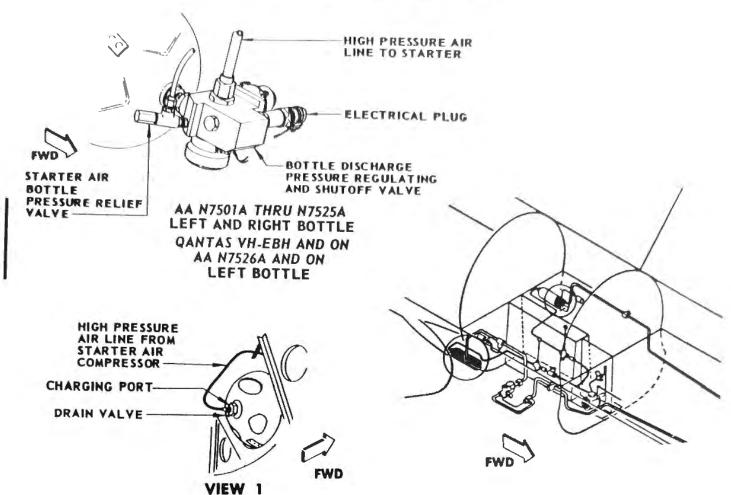
- (b) Disconnect high pressure air line from bottle discharge pressure regulating and shutoff valve.
- (c) Disconnect high pressure air line from tee fitting.
- (d) Disconnect electrical plug on bottle discharge pressure regulating and shutoff valve.
- (e) Remove heater strip from valve. Refer to 80-3-33, 'Bottle Discharge Pressure Regulating and Shutoff Valve."
- (f) Remove bottle discharge pressure regulating and shutoff valve and save for reuse if new bottle is to be installed. Refer to 80-3-33, "Bottle Discharge Pressure Regulating and Shutoff Valve."
- (7) Remove air bottle support access panels R177, R160 and R161. Refer to Chapter 12, "Access Doors and Panels."
- (8) Disconnect high pressure air line from charging port on aft end of bottle.
- (9) Loosen the two bottle support clamps and remove bottle through forward access opening.
- (10) Plug air lines unless a new bottle is to be immediately installed.
- C. Install Right Starter Air Bottle (See figure 201.)
 - (1) Slip starter air bottle into the two bottle support clamps and position air bottle so that ports on valves and fittings line up with air lines.
 - (2) Tighten support clamps until bottle is held in position.

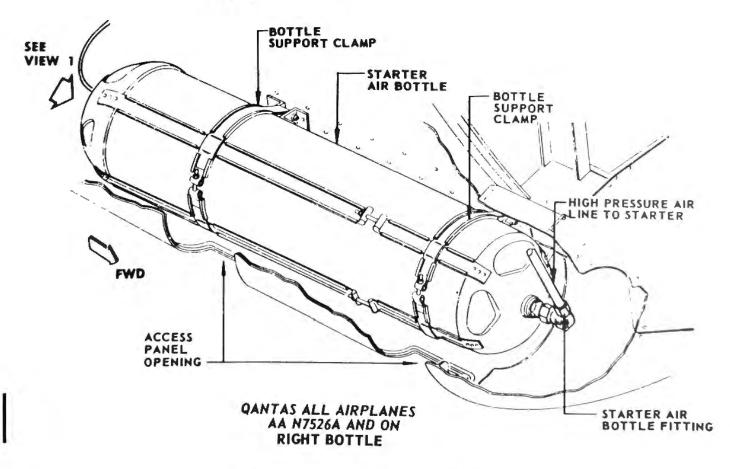
NOTE: Do not apply final torque on clamp bolts. Bottle may have to be repositioned.



- (3) On all QANTAS airplanes and on AA airplane N7526A and on, remove plugs from air lines and connect high pressure air line to forward end of starter air bottle.
- (4) On AA airplanes N7501A through N7525A, proceed as follows:
 - (a) Connect bottle discharge pressure regulating and shutoff valve to bottle if bottle was replaced.
 - (b) Remove plugs from air lines and connect high pressure air line to bottle discharge pressure regulating and shutoff valve. Reposition bottle as necessary to make connections.
 - (c) Connect high pressure air line to tee fitting.
 - (d) Replace heater strip on valve. Refer to 80-3-33, "Bottle Discharge Pressure Regulating and Shutoff Valve."
 - (e) Connect electrical plug on bottle discharge pressure regulating and shutoff valve.
 - (f) Close "HIGH PRESS REG VALVE HTR" circuit breaker on 115V a-c bus No. 2 panel (P2).
- (5) Connect high pressure air line to charging port on aft end of bottle. Reposition bottle as necessary to make connections.
- (6) Tighten bottle support clamp bolts and torque nuts from 20 to 30 pound-inches.
 - NOTE: When making a check of torque on a full bottle charged to 3000 psig the bottle support clamp should be torqued from 50 to 70 pound-inches.
- (7) Recharge starter air bottle. Refer to Chapter 12, "Air and Nitrogen Servicing."
- (8) Check lines for leaks under pressure.
- (9) Remove main landing gear door down lock.
- (10) Close right main landing gear wheel well door and install access panels 42, R177, R160 and R161.
- 3. Removal/Installation Left Starter Air Bottle (AA all airplanes, QANTAS VH-EBH and on)
 - A. Equipment and Materials
 - (1) Down lock, main landing gear door F71127 or equivalent









- B. Remove Left Starter Air Bottle (See figure 201.)
 - (1) Open left main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Remove starter air bottle fitting access panel 46. Refer to Chapter 12, "Access Doors and Panels."
 - (4) Discharge high pressure air from starter air bottle by removing cap from left ground charging valve and slowly turning hex nut counterclockwise.
 - (5) Open "HIGH PRESS REG VALVE HTR" circuit breaker on 115V a-c bus No. 2 panel (P2) if airplane a-c electrical system is in operation.
 - CAUTION: BEFORE REMOVING VALVE ASCERTAIN VALVE IS NOT TOO HOT TO HANDLE.
 - (6) Disconnect high pressure air line from bottle discharge pressure regulating and shutoff valve.
 - (7) Disconnect high pressure air line from tee fitting.
 - (8) Disconnect electrical plug on bottle discharge pressure regulating and shutoff valve.
 - (9) Remove heater strip from valve. Refer to 80-3-33, "Bottle Discharge Pressure Regulating and Shutoff Valve."
 - (10) Remove bottle discharge pressure regulating and shutoff valve and save for reuse if new bottle is to be installed. Refer to 80-3-33, "Bottle Discharge Pressure Regulating and Shutoff Valve."
 - (11) Remove air bottle support access panels L177, L160 and L161.
 - (12) Disconnect high pressure air line from charging port on aft end of bottle.
 - (13) Loosen the two bottle support clamps and remove bottle through forward access opening.
 - (14) Plug air lines unless a new bottle is to be immediately installed.



MAINTENANCE MANUAL

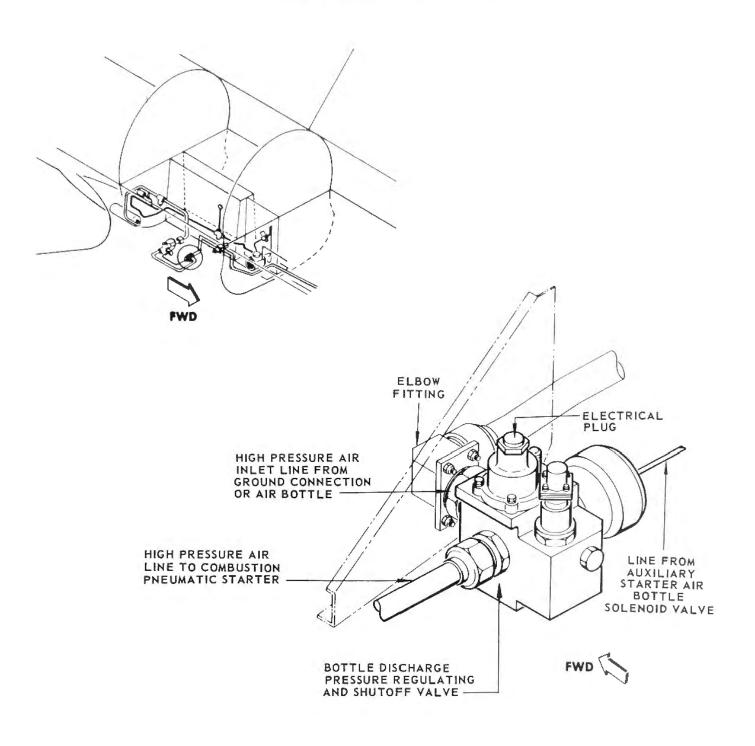
- C. Install Left Starter Air Bottle (See figure 201.)
 - (1) Connect bottle discharge pressure regulating and shutoff valve to bottle if bottle was replaced.
 - (2) Slip starter air bottle into the two bottle support clamps and position air bottle so that ports on valves and fittings line up with air lines.
 - (3) Tighten support clamps until bottle is held in position.
 - NOTE: Do not apply final torque on clamp bolts. Bottle may have to be repositioned.
 - (4) Remove plugs from air lines and connect high pressure air line to bottle discharge pressure regulating and shutoff valve. Reposition bottle as necessary to make connections.
 - (5) Connect high pressure air line to tee fitting.
 - (6) Replace heater strip on valve. Refer to 80-3-33, "Bottle Discharge Pressure Regulating and Shutoff Valve."
 - (7) Connect electrical plug on bottle discharge pressure regulating and shutoff valve.
 - (8) Connect high pressure air line to charging port on aft end of
 - (9) Tighten bottle support clamp bolts and torque nuts from 20 to 30 pound-inches.
 - When making a check of torque on a full lottle charged to 3000 psig the bottle support clamp nuts should be torqued from 50 to 70 pound-inches.
 - (10) Recharge starter air bottle. Refer to Chapter 12, "Air and Nitrogen Servicing."
 - (11) Check lines for leaks under pressure.
 - (12) Close "HIGH PRESS REG VALVE HTR" circuit breaker on 115V a-c bus No. 2 panel (P2).
 - (13) Remove main landing gear door down lock.
 - (14) Close left main landing gear wheel well door and install access panels 46, L177, R160 and R161.



BOTTLE DISCHARGE PRESSURE REGULATING AND SHUTOFF VALVE - MAINTENANCE PRACTICES

- 1. Removal/Installation Bottle Discharge Pressure Regulating and Shutoff Valve
 - A. Equipment and Materials
 - (1) Down lock main landing gear door, F71127 or equivalent.
 - B. Remove Bottle Discharge Pressure Regulating and Shutoff Valve (See figure 201.)
 - (1) Open right main landing gear door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Discharge high pressure air from starter air bottle by removing cap from ground charging valve and slowly turning hex nut counterclockwise.
 - (4) Disconnect electrical connector.
 - (5) Disconnect 3/4 inch high pressure air outlet line.
 - (6) Disconnect 1/8 inch line at the outboard side of the valve.
 - (7) Disconnect valve from 3/4 inch inlet line and remove valve.
 - C. Install Bottle Discharge Pressure Regulating and Shutoff Valve (See figure 201.)
 - (1) Place backup ring and O-ring on valve inlet fitting at elbow and connect valve to inlet line.
 - (2) Connect 1/8 inch line to valve.
 - (3) Connect 3/4 inch high pressure air outlet line.
 - (4) Connect electrical connector.
 - (5) Recharge starter air bottle. Refer to "Air and Nitrogen Servicing", Chapter 12.
 - (6) Check lines for leaks under pressure.
 - (7) Remove main landing gear door down lock.
 - (8) Close right main landing gear door.





Bottle Discharge Pressure Regulating and Shutoff Valve Installation Figure 201

END



BOTTLE DISCHARGE PRESSURE REGULATING AND SHUTOFF VALVE - MAINTENANCE PRACTICES

EFFECTIVITY

AA QANTAS 707-123B 707-138B

1. General

A. Paragraph 2 provides the procedure for removal and installation of the airplane right side bottle discharge pressure regulating and shutoff valve for all QANTAS airplanes and AA airplanes N7526A and on. Paragraph 3 provides the procedure for removal and installation of the airplane left side bottle discharge pressure regulating and shutoff valve for QANTAS airplanes VH-EBH and on and all AA airplanes. In addition, the procedure provided in paragraph 3 is used for removal and installation of the right side valve on AA airplanes N7501A through N7525A with the exception that the valve is located in the right wheel well.

2. Removal/Installation Right Bottle Discharge Pressure Regulating and Shutoff Valve

- A. Equipment and Materials
 - (1) Down lock, main landing gear door F71127 or equivalent
- B. Remove Right Bottle Discharge Pressure Regulating and Shutoff Valve (See figure 201.)
 - (1) Open right main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Discharge high pressure air from starter air bottle by removing cap from ground charging valve and slowly turning hex nut counterclockwise.
 - (4) Open "HIGH PRESS REG VALVE HTR" circuit breaker on 115V a-c bus No. 2 panel (P2) if airplane a-c electrical system is in operation.

CAUTION: BEFORE REMOVING VALVE ASCERTAIN VALVE IS NOT TOO HOT TO HANDLE.

- (5) Disconnect electrical plug (2).
- (6) Disconnect 3/4 inch high pressure air outlet line (4).
- (7) Disconnect 1/4 inch line (3) at the outboard side of valve.



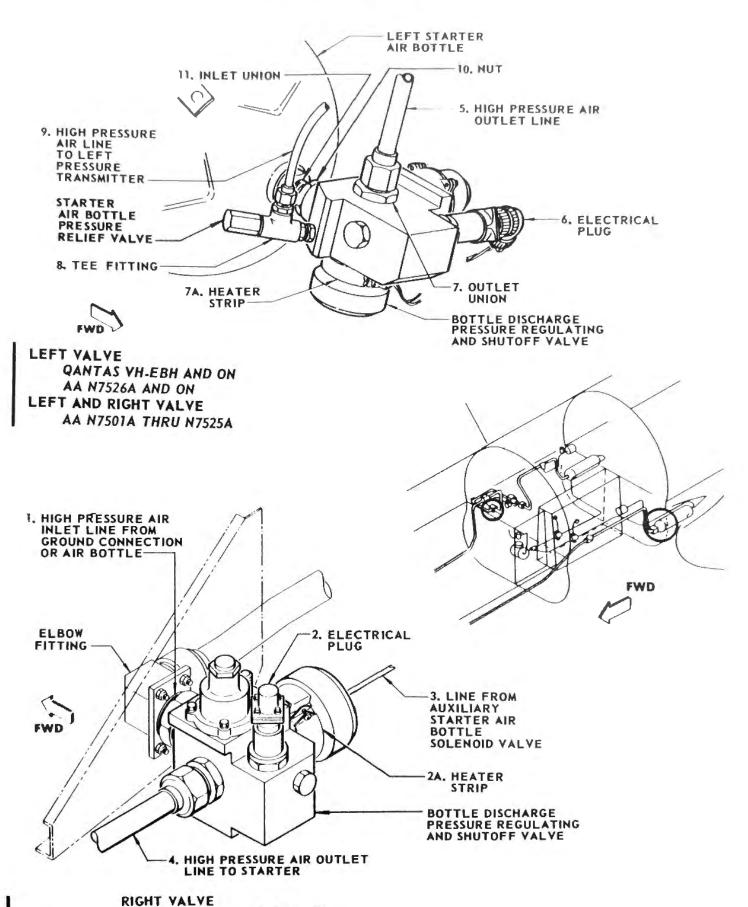
MAINTENANCE MANUAL

(8) Disconnect heater strip electrical leads, clamp bolt and remove heater strip (2A) from valve.

CAUTION: IF HEATER STRIP IS REMOVED FROM VALVE WITHOUT DISCONNECTING ELECTRICAL LEADS, APPLICATION OF ELECTRICAL POWER CAN RESULT IN BURNING OUT HEATER STRIP.

- (9) Remove valve from 3/4 inch inlet line (1) by undoing union nut and turning valve counterclockwise.
- C. Install Right Bottle Discharge Pressure Regulating and Shutoff Valve (See figure 201.)
 - (1) Place backup ring and 0-ring on valve inlet fitting at elbow and connect valve to inlet line (1).
 - (2) Connect 1/4 inch high pressure air line (3) to valve.
 - (3) Connect 3/4 inch high pressure air outlet line (4).
 - (4) Replace heater strip (2A) on valve.
 - (5) Connect electrical plug (2).
 - (6) Recharge starter air bottle. Refer to Chapter 12, "Air and Nitrogen Servicing."
 - (7) Check lines for leaks under pressure.
 - (8) Close "HIGH PRESS REG VALVE HTR" circuit breaker on 115V a-c bus No. 2 panel (P2).
 - (9) With electrical power applied to 115V a-c bus No. 2 panel (P2) and "HIGH PRESS REG VALVE HTR" circuit breaker closed, to ensure that heater strip is operative, check that the heater strip is warm to the touch if ambient temperature is below 100°F.
 - (10) Remove main landing gear door down lock.
 - (11) Close right main landing gear wheel well door.
- 3. Removal/Installation Left Bottle Discharge Pressure Regulating and Shutoff Valve (QANTAS-VH-EBH and on, AA-all, This procedure also applies for AA-N7501A through N7525A airplanes for right valve removal/installation with the exception that valve is in right wheel well)
 - A. Equipment and Materials
 - (1) Down lock, main landing gear door F71127 or equivalent





QANTAS ALL AIRPLANES AA N7526A AND ON

2 Bottle Discharge Pressure Regulating and Shutoff Valve Installation
May 15/61 Figure 201 80-3-33
Revised Page 203



- B. Remove Left Bottle Discharge Pressure Regulating and Shutoff Valve (See figure 201.)
 - (1) Open left main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Remove starter air bottle fitting access panel 46. Refer to Chapter 12, "Access Doors and Panels."
 - (4) Discharge high pressure air from starter air bottle by removing cap from ground charging valve and slowly turning hex nut counterclockwise.
 - (5) Open "HIGH PRESS REG VALVE HTR" circuit breaker on 115V ac bus No. 2 panel (P2) if airplane a-c electrical system is in operation.

CAUTION: BEFORE REMOVING VALVE ASCERTAIN VALVE IS NOT TOO HOT TO HANDLE.

- (6) Disconnect high pressure air line (9) and high pressure air outlet line (5).
- (7) Disconnect electrical plug (6).
- (8) Remove tee fitting (8).

NOTE: Do not remove pressure relief valve from tee fitting.

- (9) Remove outlet union (7) from outlet side of valve and save for reinstallation.
- (10) Disconnect heater strip electrical leads, clamp bolt and remove heater strip (7A) from valve.

CAUTION: IF HEATER STRIP IS REMOVED FROM VALVE WITHOUT DISCONNECTING ELECTRICAL LEADS, APPLICATION OF ELECTRICAL POWER CAN RESULT IN BURNING OUT HEATER STRIP.

- (11) Remove bottle discharge pressure regulating and shutoff valve from bottle by undoing large nut (10) holding valve to inlet union (11) and turning valve counterclockwise.
- C. Install Left Bottle Discharge Pressure Regulating and Shutoff Valve (See figure 201.)
 - (1) Place backup ring and O-ring on outlet union (7) and install long end of union into outlet side of bottle discharge pressure regulating and shutoff valve.



(2) Place 0-ring and backup ring on starter air bottle pressure relief valve tee fitting (8) and install into side of bottle discharge pressure regulating and shutoff valve.

NOTE: Do not remove pressure relief valve from tee fitting.

(3) Place backup ring and O-ring on inlet union (11) in end of starter air bottle and install bottle discharge pressure regulating and shutoff valve to union by turning clockwise.

NOTE: Mount bottle discharge pressure regulating and shutoff valve approximately 20 degrees off vertical position in outboard direction. This will facilitate connection of air lines to valve fittings.

- (4) Connect high pressure air line (9) to tee fitting (8) and high pressure air outlet line (5) to valve.
- (5) Replace heater strip (7A) on valve.
- (6) Connect electrical plug (6).
- (7) Recharge starter air bottle. Refer to Chapter 12, "Air and Nitrogen Servicing."
- (8) Check lines for leaks under pressure.
- (9) Install starter air bottle fitting access panel 46.
- (10) Close "HIGH PRESS REG VALVE HTR" circuit breaker on 115V ac bus No. 2 panel (P2).
- (11) With electrical power applied to 115-V AC bus No. 2 panel (P2) and "HIGH PRESS REG VALVE HTR" circuit breaker closed, to ensure that heater strip is operative, check that the heater strip is warm to the touch if ambient temperature is below 100°F.
- (12) Remove main landing gear door down lock.
- (13) Close left main landing gear wheel well door.

COMBUSTOR AIR PRESSURE RELIEF VALVE - MAINTENANCE PRACTICES

EFFECTIVITY

VH-EBA THRU VH-EBD

- 1. Removal/Installation Combustor Air Pressure Relief Valve
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Combustor Air Pressure Relief Valve (See figure 201.)

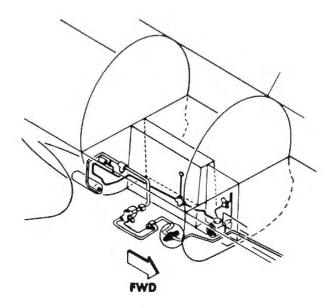
WARNING: ASCERTAIN THAT PRESSURE SELECTOR SWITCH ON OVERHEAD PANEL IS IN GUARDED "OFF" POSITION.

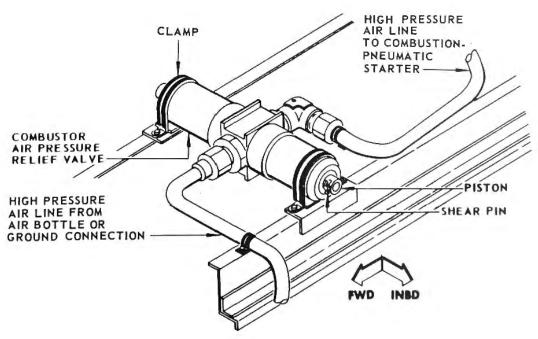
- (1) Open right main landing gear door and place door ground release handle in down and latched position.
- (2) Install main landing gear door down lock.
- (3) Disconnect inlet and outlet high pressure air lines from pressure relief valve.
- (4) Unfasten clamps by removing two screws on each clamp.
- (5) Remove clamps and pressure relief valve.
- C. Install Combustor Air Pressure Relief Valve (See figure 201.)
 - (1) Position clamps and pressure relief valve.
 - (2) Install two screws on each clamp.
 - (3) Connect inlet and outlet high pressure air lines to pressure relief valve.
 - (4) Remove main landing gear door down lock.
 - (5) Close right main landing gear wheel well door.



2. Inspection/Check Combustor Air Pressure Relief Valve

- A. Check Combustor Air Pressure Relief Valve
 - (1) Make visual check of the valve to ascertain that shear pins are intact.
 - (2) If shear pins are not intact, then remove valve and replace with a serviceable one.





COMBUSTOR AIR PRESSURE RELIEF VALVE - MAINTENANCE PRACTICES

EFFECTIVITY

AA N752LA AND ON QANTAS VH-EBE AND ON BNF ALL AIRPLANES

- 1. Removal/Installation Combustor Air Pressure Relief Valve
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Combustor Air Pressure Relief Valve (See figure 201.)

WARNING: ASCERTAIN THAT PRESSURE SELECTOR SWITCH ON OVERHEAD PANEL IS IN GUARDED "OFF" POSITION.

- (1) Open main landing gear wheel well door and place door ground release handle in down and latched position.
- (2) Install main landing gear door down lock.
- (3) Disconnect inlet and outlet high pressure air lines from pressure relief valve.
- (4) Remove eight screws attaching external skin-patch to Wing-fuselage fairing to obtain access to coupling nut.
- (5) Unscrew coupling nut from pressure relief valve assembly.
- (6) Unscrew self-locking nuts and remove strap, washers and clamp holding valve to mounting bracket.
- (7) Remove pressure relief valve assembly from seal pan.
- C. Install Combustor Air Pressure Relief Valve (See figure 201.)
 - (1) Position valve assembly and clamp on mounting bracket.
 - (2) Replace strap, washers and self-locking nuts on clamp ends and fasten valve to mounting bracket.

NOTE: Do not fully tighten nuts until air lines have been connected.

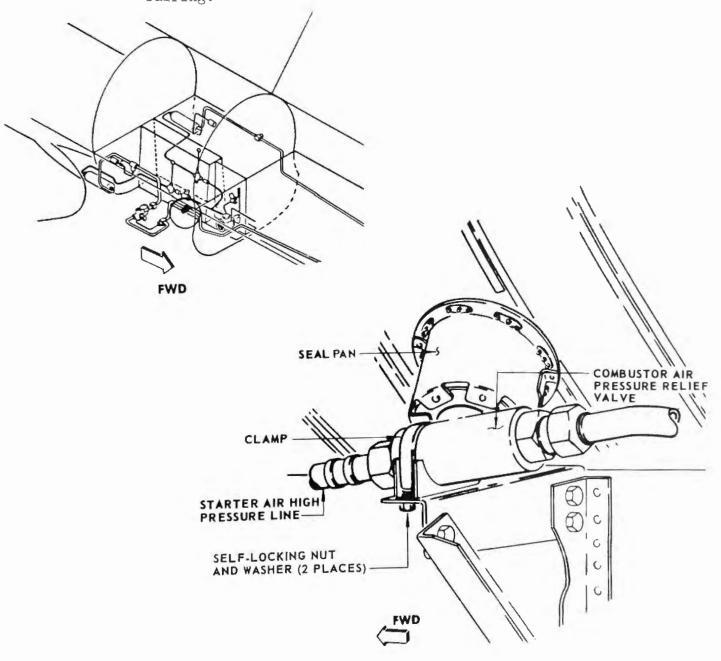
- (3) Connect coupling nut to pressure relief valve assembly and apply a final torque of 700-900 pound inches.
- (4) Attach external skin-patch to fairing with eight screws.
- (5) Connect high pressure air lines to pressure relief valve.



- (6) Remove main landing gear door down lock.
- (7) Close main landing gear wheel well door.

2. Inspection/Check Combustor Air Pressure Relief Valve

- A. Check Combustor Air Pressure Relief Valve (See figure 201.)
 - (1) Make visual check of external skin-patch on upper surface of wing-fuselage fairing to ascertain that valve has not operated and that rupture disc is intact.
 - (2) If external patch and rupture disc have been blown out, remove valve and replace with a serviceable one, and install a new skin-patch on fairing.



HIGH PRESSURE AIR RELIEF VALVE - MAINTENANCE PRACTICES

EFFECTIVITY

AA 707-123B and QANTAS 707-138B

- 1. Removal/Installation High Pressure Air Relief Valve
 - A. Equipment and Materials
 - (1) Down Lock Main Landing Gear Door F71127 or equivalent.
 - B. Remove High Pressure Air Relief Valve (See figure 201.)

WARNING: ASCERTAIN THAT PRESSURE SELECTOR SWITCH ON OVERHEAD PANEL IS IN GUARDED "OFF" POSITION.

- (1) Open main landing gear wheel well door and place door ground release handle in down and latched position.
- (2) Install main landing gear door down lock.
- (3) Disconnect inlet and outlet high pressure air lines from pressure relief valve.
- (4) Remove eight screws attaching skin-patch to fairing fuselage to obtain access to coupling nut.
- (5) Unscrew coupling nut from pressure relief valve assembly.
- (6) Unscrew two self-locking nuts and washers and remove clamp.
- (7) Remove pressure relief valve assembly from seal pan.
- C. Install High Pressure Air Relief Valve (See figure 201.)
 - (1) Position pressure relief valve assembly on mounting bracket and seal pan.
 - (2) Install clamp using two self-locking nuts and washers.

NOTE: Do not fully tighten nuts until air lines have been connected.

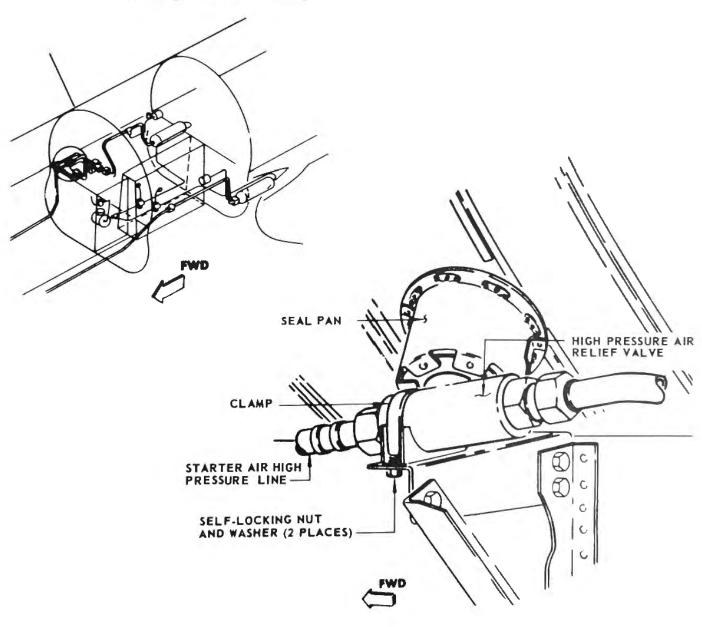
- (3) Connect coupling nut to pressure relief valve assembly and apply final torque of 700 900 pound-inches.
- (4) Attach skin-patch to fairing with eight screws.
- (5) Connect high pressure air lines to pressure relief valve.



- (6) Remove main landing gear door down lock.
- (7) Close main landing gear wheel well door.

2. Inspection/Check High Pressure Air Relief Valve

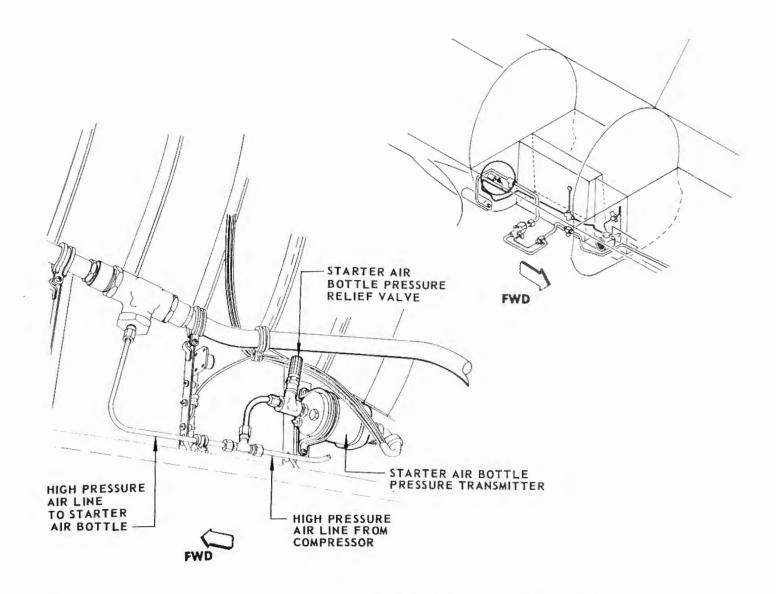
- A. Check Combustor Air Pressure Relief Valve (See figure 201.)
 - (1) Make visual check of external skin-patch on upper surface of wing-body fairing to ascertain that valve has not operated and that rupture disc is intact.
 - (2) If external patch and rupture disc have been blown out, remove valve and replace with a serviceable one, and install a new skin-patch on fairing





STARTER AIR BOTTLE PRESSURE RELIEF VALVE - MAINTENANCE PRACTICES

- 1. Removal/Installation Starter Air Bottle Pressure Relief Valve
 - A. Equipment and Materials
 - (1) Down Lock Main Landing Gear Door F71127 or equivalent.
 - B. Remove Starter Air Bottle Pressure Relief Valve (See figure 201.)
 - (1) Open main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Discharge high pressure air from starter air bottle by removing cap from ground charging valve and slowly turning hex nut counterclockwise.





- (4) Remove pressure relief valve by turning counterclockwise until valve separates from tee-fitting attached to pressure transmitter.
- C. Install Starter Air Bottle Pressure Relief Valve (See figure 201.)
 - (1) Install new 0-ring into groove on attaching fitting end.
 - (2) Thread pressure relief valve into tee-fitting attached to pressure transmitter.
 - (3) Recharge starter air bottle. Refer to "Air and Nitrogen Servicing", Chapter 12.
 - (4) Check for leaks under pressure.
 - (5) Remove main landing gear door down lock.
 - (6) Close right main landing gear door.

END



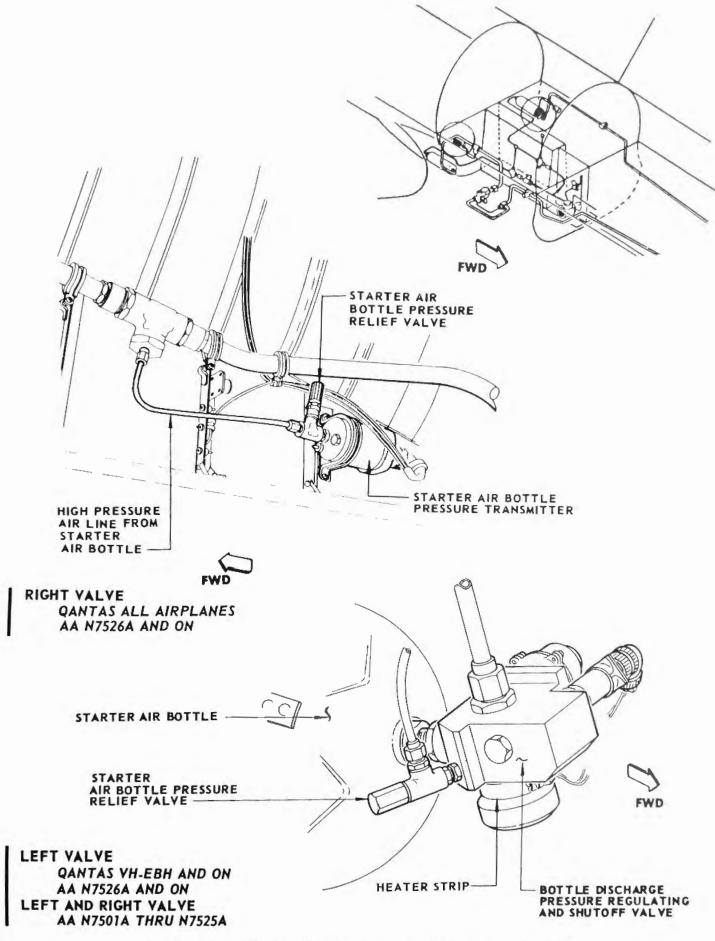
STARTER AIR BOTTLE PRESSURE RELIEF VALVE - MAINTENANCE PRACTICES

EFFECTIVITY

AA 707-123B QANTAS 707-138B

- 1. Removal/Installation Starter Air Bottle Pressure Relief Valve
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Starter Air Bottle Pressure Relief Valve (See figure 201.)
 - (1) Open main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Discharge high pressure air from starter air bottle by removing cap from ground charging valve and slowly turning hex nut counterclockwise.
 - (4) Remove starter air bottle fitting access panel when removing left pressure relief valve.
 - (5) Remove pressure relief valve by turning counterclockwise until valve separates from fitting.
 - C. Install Starter Air Bottle Pressure Relief Valve (See figure 201.)
 - (1) Install new O-ring and backup ring on fitting end.
 - (2) Thread pressure relief valve to fitting and tighten.
 - (3) Replace starter air bottle fitting access panel when installing left pressure relief valve.
 - (4) Recharge starter air bottle. Refer to Chapter 12, "Air and Nitrogen Servicing."
 - (5) Remove main landing gear door down lock.
 - (6) Close main landing gear wheel well door.



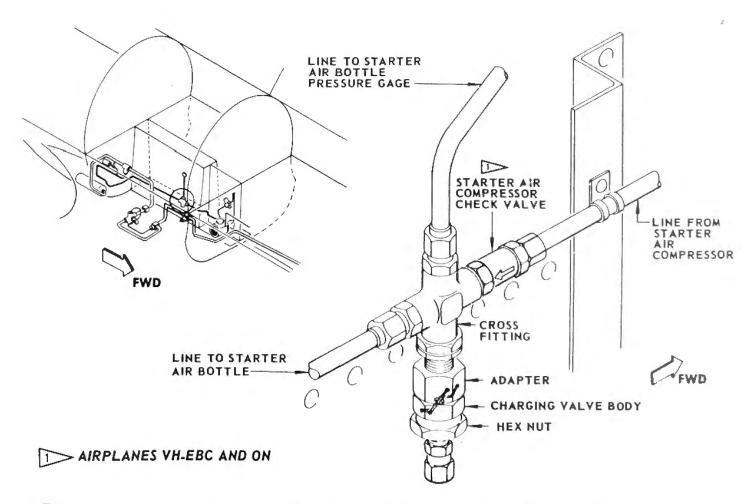


Starter Air Bottle Pressure Relief Valve Installation Figure 201



STARTER AIR BOTTLE GROUND CHARGING VALVE - MAINTENANCE PRACTICES

- 1. Removal/Installation Starter Air Bottle Ground Charging Valve
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Starter Air Bottle Ground Charging Valve (See figure 201.)
 - (1) Open main landing gear wheel well door and place door release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Discharge high pressure air from starter air bottle by removing cap from ground charging valve and slowly turning hex nut counterclockwise.
 - (4) Remove lockwire; remove ground charging valve by turning charging valve body counterclockwise.







- Install Starter Air Bottle Ground Charging Valve (See figure 201.)
 - Install O-ring and screw charging valve body onto adapter by turning valve body clockwise; lockwire.
 - Recharge starter air bottle. Refer to Chapter 12, "Air and Nitrogen Servicing."
 - (3) Check lines and fittings for leaks under pressure.
 - (4) Remove main landing gear door down lock.
 - (5) Close main landing gear wheel well door.

END

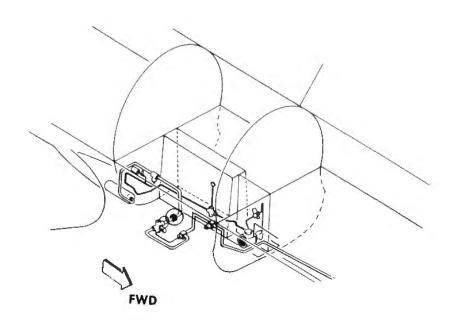


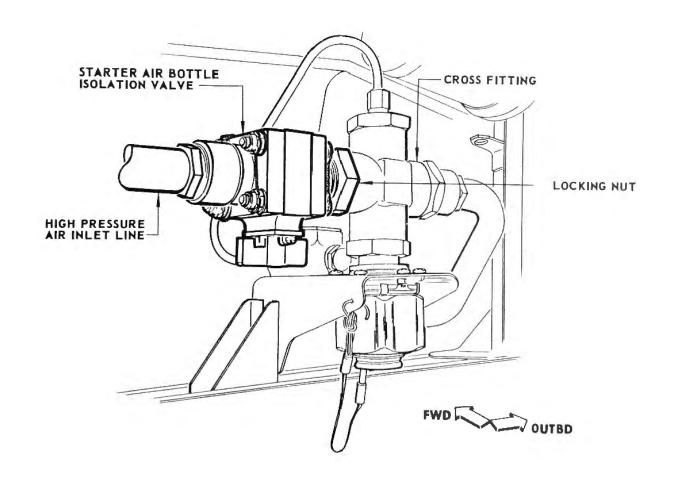
STARTER AIR BOTTLE ISOLATION VALVE - MAINTENANCE PRACTICES

- 1. Removal/Installation Starter Air Bottle Isolation Valve
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Starter Air Bottle Isolation Valve (See figure 201.)
 - (1) Open right main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Discharge high pressure air from starter air bottle by removing cap from right ground charging valve and slowly turning hex nut counterclockwise.
 - (4) Disconnect 3/4 inch high pressure air inlet line at inboard side of the valve.
 - (5) Loosen 1 inch locking nut on union at valve outlet.
 - (6) Remove isolation valve.
 - C. Install Starter Air Bottle Isolation Valve (See figure 201.)
 - (1) Replace O-rings and thread isolation valve with outlet union into cross fitting.
 - (2) Tighten 1 inch locking nut against cross fitting.
 - (3) Connect 3/4 inch high pressure air inlet line to inboard side of valve.
 - (4) Recharge starter air bottle and check for leaks under pressure. Refer to Chapter 12, "Air and Nitrogen Servicing".
 - (5) Remove main landing gear door down lock.
 - (6) Close right main landing gear wheel well door.



STARTING Starter Air Bottle Isolation Valve Maintenance Practices



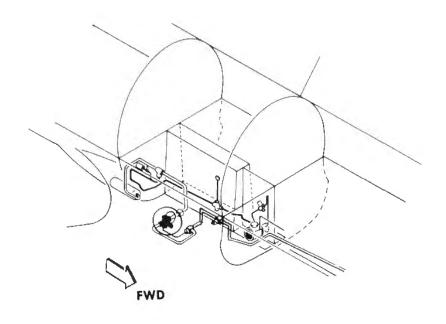


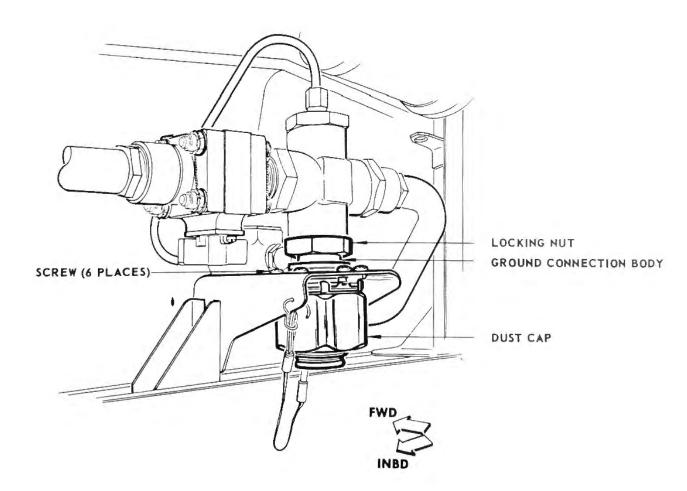


AUXILIARY STARTER AIR BOTTLE GROUND CONNECTION - MAINTENANCE PRACTICES

- 1. Removal/Installation Auxiliary Starter Air Bottle Ground Connection
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Auxiliary Starter Air Bottle Ground Connection (See figure 201.)
 - (1) Open right main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Discharge high pressure air from starter air bottle by removing cap from right ground charging valve and slowly turning hex nut counterclockwise.
 - (4) Remove ground connection dust cap.
 - (5) Remove 6 Phillips head screws and nuts attaching connection to support plate.
 - (6) Loosen 1 inch locking nut.
 - (7) Remove ground connection body by turning counterclockwise until it separates from large cross fitting.
 - C. Install Auxiliary Starter Air Bottle Ground Connection (See figure 201.)
 - (1) Replace O-rings and thread ground connection into cross fitting.
 - (2) Tighten 1 inch locking nut against cross fitting.
 - (3) Replace 6 Phillips head screws and nuts to fasten connection to support plate.
 - (4) Thread dust cap onto ground connection.
 - (5) Recharge starter air bottle and check for leaks under pressure. Refer to Chapter 12, "Air and Nitrogen Servicing".
 - (6) Remove main landing gear door down lock.
 - (7) Close right main landing gear wheel well door.





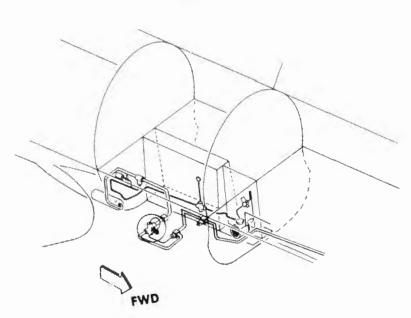


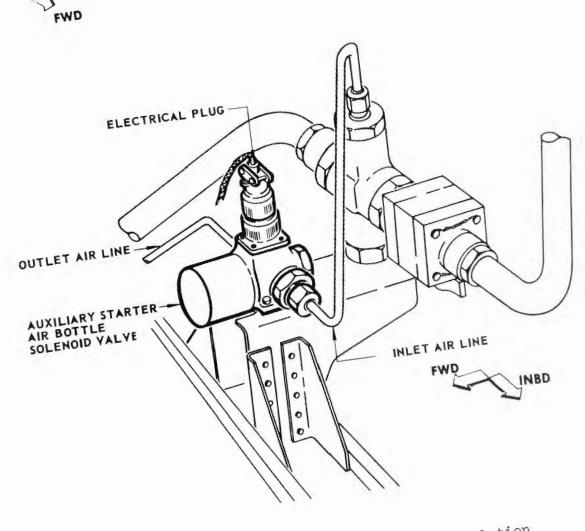
Auxiliary Starter Air Bottle Ground Connection Installation Figure 201

AUXILIARY STARTER AIR BOTTLE SOLENOID VALVE - MAINTENANCE PRACTICES

- 1. Removal/Installation Auxiliary Starter Air Bottle Solenoid Valve
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Auxiliary Starter Air Bottle Solenoid Valve (See figure 201.)
 - (1) Open right main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Discharge high pressure air from starter air bottle by removing cap from right ground charging valve and slowly turning hex nut counterclockwise.
 - (4) Disconnect electrical plug from solenoid valve.
 - (5) Disconnect 1/4" inlet air line at fitting on inboard side of valve.
 - (6) Disconnect 1/4" outlet air line at fitting on outboard side of valve.
 - (7) Remove 2 machine screws and nuts fastening valve body to support plate and remove valve.
 - C. Install Auxiliary Starter Air Bottle Solenoid Valve (See figure 201.)
 - (1) Position valve and fasten to support plate with 2 machine screws and nuts.
 - (2) Connect 1/4" outlet air line to fitting on outboard side of valve.
 - (3) Connect 1/4" inlet air line to fitting on inboard side of valve.
 - (4) Connect electrical plug to solenoid valve.
 - (5) Recharge starter air bottle and check for leaks under pressure. Refer to Chapter 12, "Air and Nitrogen Servicing".
 - (6) Remove main landing gear door down lock.
 - (7) Close right main landing gear wheel well door.







Auxiliary Starter Air Bottle Solenoid Valve Installation Figure 201

STARTER AIR COMPRESSOR - MAINTENANCE PRACTICES

- 1. Removal/Installation Starter Air Compressor
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Starter Air Compressor. (See figure 201.)
 - (1) Open main landing gear wheel well door and place door release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Open starter air compressor circuit breakers.
 - (4) Disconnect electrical plug (1) on starter air compressor.
 - (5) Depressurize utility hydraulic system. Refer to Chapter 29, "Utility Hydraulic System."

CAUTION: PROTECT EQUIPMENT AGAINST SPILLED HYDRAULIC FLUID.

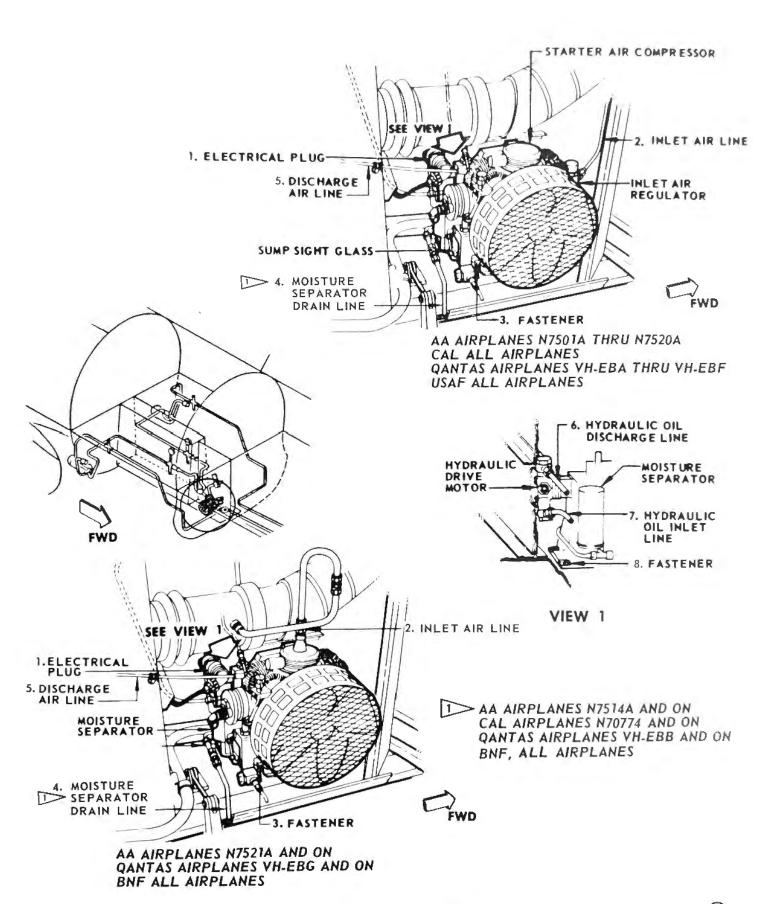
- (6) Disconnect compressor air inlet line (2).
- (7) Disconnect 1/4 inch discharge air line (5).
- (8) Open aft antenna access door. Refer to Chapter 12, "Access Doors and Panels."
- (9) Disconnect moisture separator drain line (4).
- (10) Remove four fasteners (3 and 8) and washers attaching starter air compressor to structure.
- (11) Disconnect hydraulic oil inlet (7) from hydraulic drive motor.
 - NOTE: Access to the hydraulic drive motor inlet and discharge fittings is obtained through the keel beam cutout from the left main gear wheel well.

Plug inlet line and cap drive motor inlet fitting to prevent loss of hydraulic fluid and entry of foreign matter.

- (12) Disconnect hydraulic oil discharge line (6) from hydraulic drive motor.
 - NOTE: The discharge line fitting may be more accessible if the top of the compressor is tilted outboard.

Plug discharge line and cap drive motor discharge port.







- C. Install Starter Air Compressor (See figure 201.)
 - (1) Remove plugs and caps from hydraulic lines and hydraulic drive motor.

 CAUTION: PROTECT EQUIPMENT AGAINST SPILLED HYDRAULIC FLUID.
 - (2) Position starter air compressor.
 - (3) Connect hydraulic oil discharge line (6) to discharge port on drive motor.
 - (4) Connect hydraulic oil inlet line (7) to inlet port on drive motor.
 - (5) Install four fasteners (3 and 8) and washers.

NOTE: Install two short fasteners (8) on inboard side and two long fasteners (3) on outboard side.

- (6) Connect moisture separator drain line (4).
- (7) Close aft antenna access door.
- (8) Connect 1/4 inch discharge air line (5).
- (9) Connect compressor inlet air line (2).

CAUTION: BEFORE CONNECTING ELECTRICAL PLUG TO STARTER AIR

COMPRESSOR CONNECTION MAKE SURE THAT THE "AIR COMPRESSOR

TIMER" CIRCUIT BREAKER ON THE A-C BUS NO. 3 CIRCUIT

BREAKER PANEL (P3) AND THE "START AIR COMP. CONT" CIRCUIT

BREAKER ON BUS NO. 2 ON THE RADIO AND T-R CIRCUIT BREAKER

PANEL (P5) ARE OPEN.

- (10) Connect electrical plug (1) to receptacle on starter air compressor.
- (11) Check oil level at sight glass, and if compressor unit requires lubricating oil, refer to "Servicing Starter Air Compressor," 80-0.
- (12) Reset circuit breakers, pressurize utility hydraulic system, and test compressor operation. Refer to Chapter 29, "Utility Hydraulic System," and paragraph (6), 80-0, "Test Starter Air Compressor."
- (13) Remove main landing gear door down lock.
- (14) Close main landing gear wheel well door.



STARTER AIR COMPRESSOR SOLENOID VALVE - MAINTENANCE PRACTICES

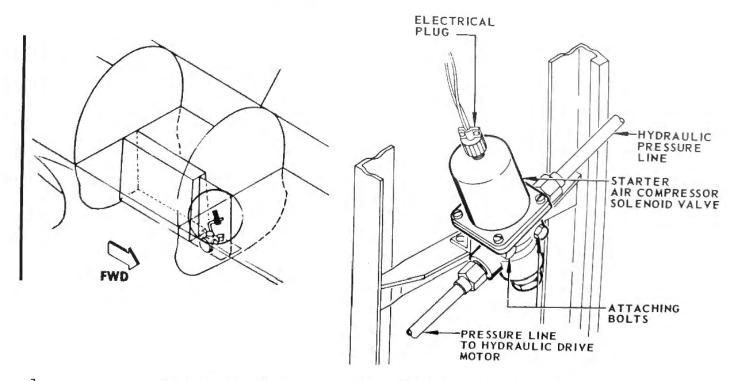
- 1. Removal/Installation Starter Air Compressor Solenoid Valve
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Starter Air Compressor Solenoid Valve (See figure 201.)
 - (1) Open main landing gear wheel well door and place main gear door release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Open "START AIR COMP CONT" circuit breaker on the radio and T-R circuit breaker panel (P5).
 - (4) Disconnect electrical plug from starter air compressor solenoid valve.

CAUTION: PROTECT EQUIPMENT AGAINST SPILLED HYDRAULIC FLUID.

(5) Disconnect hydraulic lines from forward and aft side of starter air compressor solenoid valve. Cap lines.

NOTE: If new starter air compressor solenoid valve is going to be installed, remove two unions from valve body for reuse on new valve.

(6) Remove two attaching bolts.





- C. Install Starter Air Compressor Solenoid Valve (See figure 201.)
 - (1) Install starter air compressor solenoid valve; fasten to its supporting bracket with two attaching bolts.
 - NOTE: Install starter air compressor solenoid valve with top of valve tilted aft for hydraulic lines to fit properly. In this position the forward attaching bolt is at bottom of fitting boss and aft attaching bolt is at top of fitting boss.
 - (2) Install 0-ring in groove of both forward and aft unions and install unions in starter air compressor solenoid valve body. Lockwire valve drain plug to one of unions.

CAUTION: PROTECT EQUIPMENT AGAINST SPILLED HYDRAULIC FLUID.

- (3) Remove caps from hydraulic lines and attach lines to unions on starter air compressor solenoid valve.
- (4) Connect electrical plug to receptacle on starter air compressor solenoid valve.

CAUTION: BEFORE CONNECTING ELECTRICAL PLUG TO STARTER AIR COMPRESSOR SOLENOID VALVE CHECK THAT "START AIR COMP CONT" CIRCUIT BREAKER ON THE RADIO AND T-R CIRCUIT BREAKER PANEL (P5) IS OPEN.

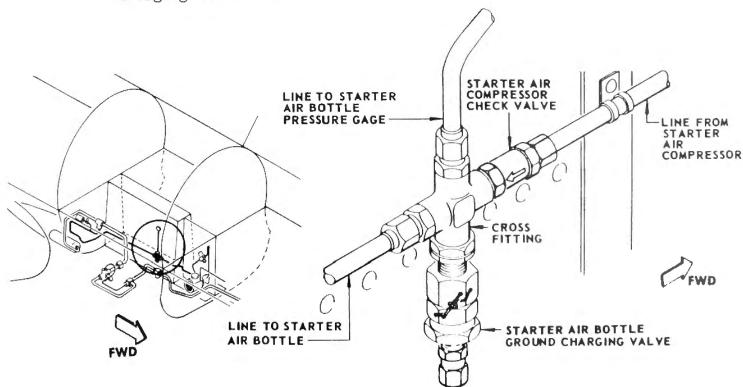
- (5) Remove main landing gear door down lock.
- (6) Close main landing gear wheel well door.

STARTER AIR COMPRESSOR CHECK VALVE MAINTENANCE PRACTICES

EFFECTIVITY

VH-EBC AND ON

- 1. Removal/Installation Starter Air Compressor Check Valve
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Starter Air Compressor Check Valve (See figure 201.)
 - (1) Open main landing gear wheel well door and place door release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Discharge high pressure air from starter air bottle by removing cap from ground charging valve and slowly turning hex nut counterclockwise.
 - (4) Disconnect air pressure line from starter air compressor at check valve.
 - (5) Unscrew check valve from forward side of cross fitting at ground charging valve.





- C. Install Starter Air Compressor Check Valve (See figure 201.)
 - (1) Install new 0-ring on free flow direction side of check valve fitting.
 - (2) Thread check valve into cross fitting with check valve free flow arrow pointing aft or into cross fitting.
 - (3) Connect air pressure line from starter air compressor to check valve.
 - (4) Recharge starter air bottle. Refer to Chapter 12, "Air and Nitrogen Servicing."
 - (5) Check lines and fittings for leaks under pressure.
 - (6) Remove main landing gear door down lock.
 - (7) Close main landing gear wheel well door.



STARTER AIR BOTTLE PRESSURE INDICATING SYSTEM-DESCRIPTION AND OPERATION

1. General

A. The starter air bottle indicating system consists of one direct reading pressure gage and an electrical pressure-indicating system. (See figure 1.) The components comprising the system are: one starter air bottle, one pressure gage, one pressure transmitter, and a pressure indicator.

2. Starter Air Bottle Pressure Gage

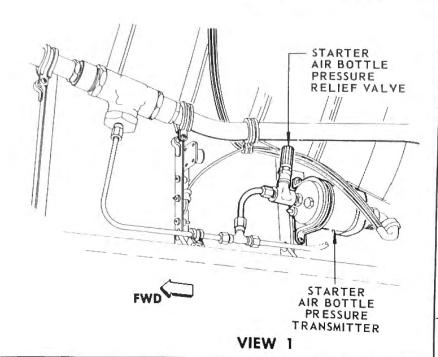
A. A direct reading starter air bottle pressure gage is located above the starter air bottle ground charging valve in a main landing gear wheel well. (See detail A, figure 1.) The air pressure line to the gage connects into the compressor-to-bottle line at the ground charging valve connection cross. This provides a constant air bottle pressure reading on the gage. The pressure gage is mounted on a bracket through a 90 degree elbow fitting, seal and nut. The bracket is attached to the wheel well structure.

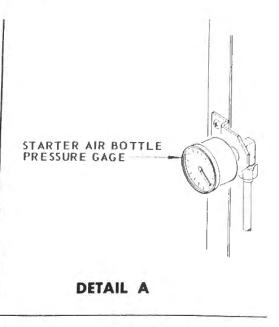
3. Starter Air Bottle Electrical Pressure-Indicating System

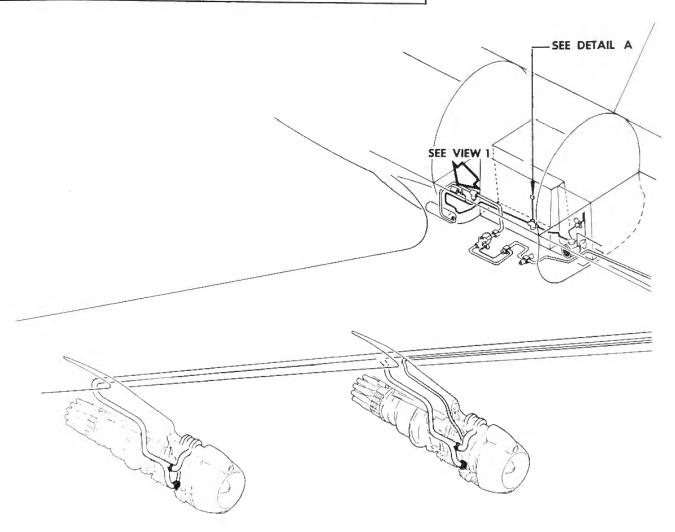
- A. The starter air bottle electrical pressure-indicating system consists of a pressure transmitter and a pressure indicator. The pressure transmitter (view 1, figure 1) is an electrically operated synchronous type and is located above the starter air bottle in the wing body fairing at the aft end of the right main landing gear wheel well. The transmitter is attached to the fairing structure by a clamp.
- B. The pressure indicator (view 2, figure 1) receives its signal from the pressure transmitter and indicates the starter air bottle pressure in pounds per square inch gage. The pressure indicator is located on the flight engineer's lower panel.
- C. The starter air bottle electrical pressure-indicating system is supplied 28-volt 400-cycle ac through a circuit breaker on the 28-volt a-c circuit breaker panel (P7). (See figure 2.)



STARTING
Starter Air Bottle
Pressure-Indicating System
Description and Operation



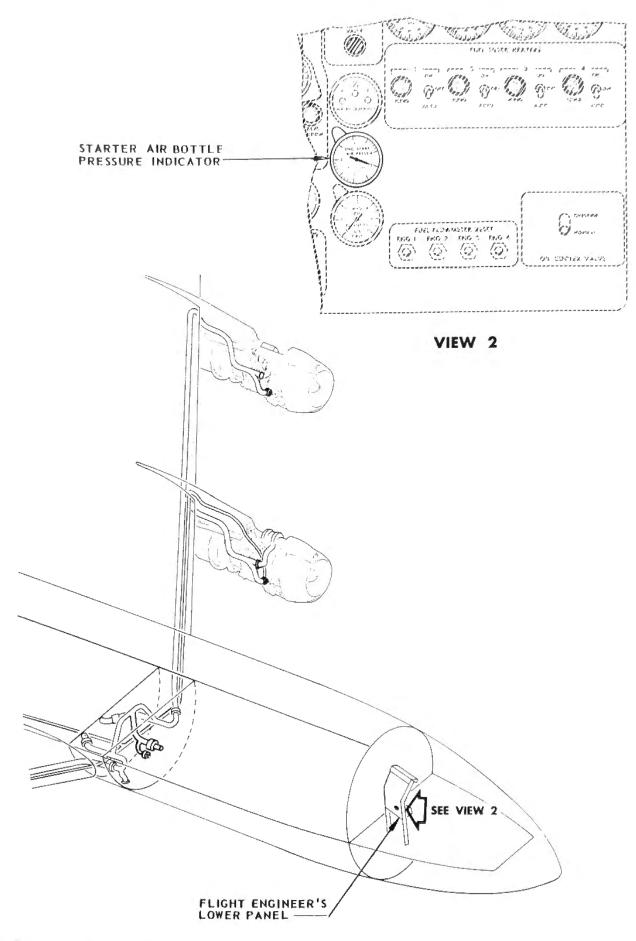




Pressure-Indicating System



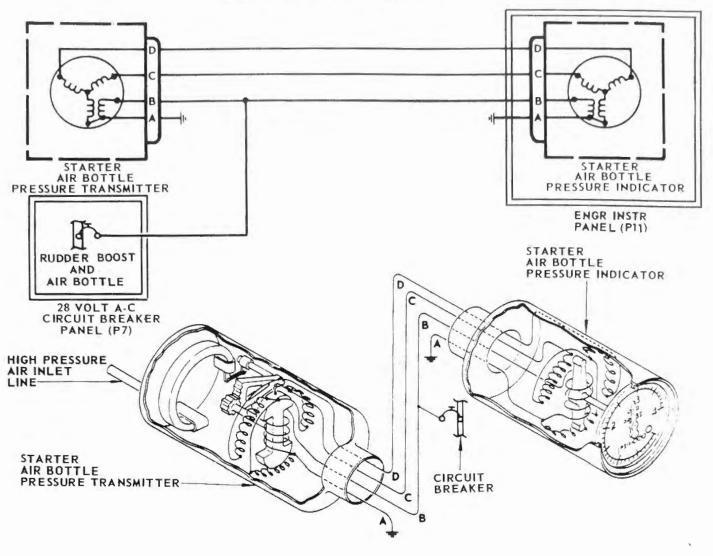
Description and Operation



Starter Air Bottle Pressure Indicating System

Description And Operation



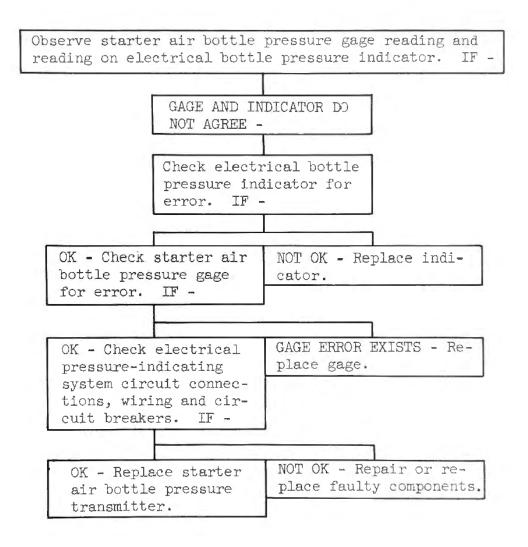


Starter Air Bottle Electrical Pressure Indicating System Schematic Figure 2



STARTER AIR BOTTLE PRESSURE-INDICATING SYSTEM - TROUBLE SHOOTING

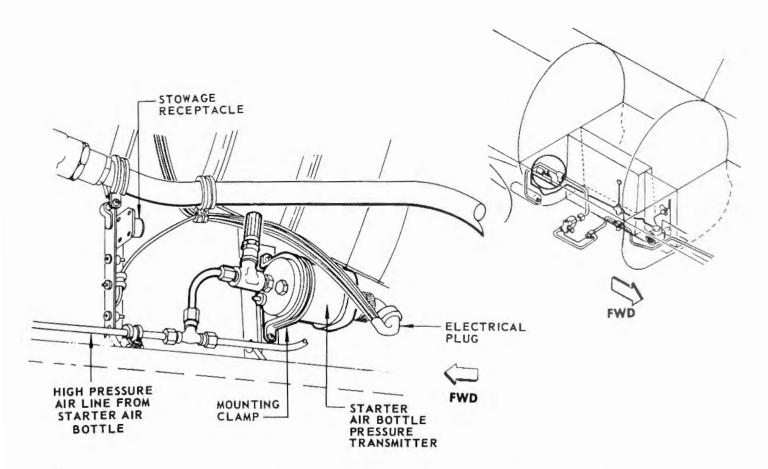
1. Starter Air Bottle Pressure-Indicating System - Trouble Shooting Chart





STARTER AIR BOTTLE PRESSURE TRANSMITTER - MAINTENANCE PRACTICES

- 1. Removal/Installation Starter Air Bottle Pressure Transmitter
 - A. Equipment and Materials
 - (1) Down Lock, Main Landing Gear Door F71127 or equivalent.
 - B. Remove Starter Air Bottle Pressure Transmitter (See figure 201.)
 - (1) Open right main landing gear wheel well door and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down lock.
 - (3) Disconnect electrical power to air bottle pressure transmitter by opening "RUDDER BOOST & AIR BOTTLE PRESS" circuit breaker on the 28-volt a-c circuit breaker panel (P7).
 - (4) Remove electrical plug from aft end of air bottle pressure transmitter and connect to stowage receptacle.
 - (5) Discharge high pressure air from starter air bottle by removing cap from starter air bottle ground charging valve and slowly turning hex nut counterclockwise.





MAINTENANCE MANUAL Maintenance Practices

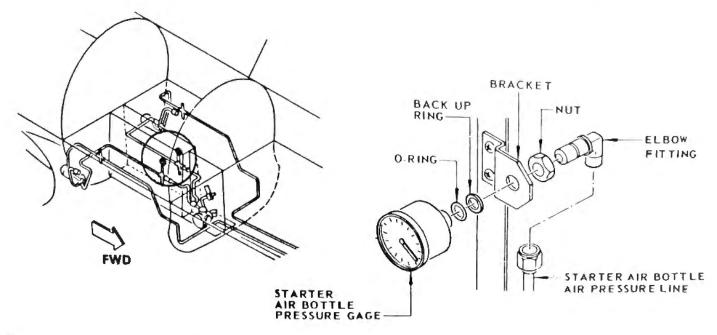
- (6) Disconnect high pressure air line on forward end of starter air bottle pressure transmitter.
 - NOTE: If new transmitter is going to be installed, remove union from old transmitter and save for reuse.
- (7) Remove mounting clamp securing transmitter to support bracket.
- (8) Remove starter air bottle pressure transmitter.
- C. Install Starter Air Bottle Pressure Transmitter (See figure 201.)
 - (1) Install union and O-ring in pressure port of transmitter.
 - (2) Attach starter air bottle pressure transmitter to its supporting bracket with two screws, two nuts, and clamp. Electrical connection on transmitter faces aft.
 - NOTE: Do not tighten clamp completely so that transmitter may be rotated to position air pressure line on union.
 - (3) Connect high pressure air line to pressure port union.
 - (4) Tighten transmitter mounting clamp by tightening two screws and nuts on attaching bracket.
 - (5) Remove electrical plug from stowage receptacle and connect to transmitter.
 - (6) Recharge starter air bottle. Refer to Chapter 12, "Air and Nitrogen Servicing."
 - (7) Check lines and fittings for leaks under pressure.
 - (8) Remove main landing gear door down lock.
 - (9) Close right main landing gear wheel well door.

STARTER AIR BOTTLE PRESSURE GAGE - MAINTENANCE PRACTICES

1. Removal/Installation Starter Air Bottle Pressure Gage

- A. Equipment and Materials
 - (1) Down Lock Main Landing Gear Door F71127 or equivalent.
- B. Remove Starter Air Bottle Pressure Gage (See figure 201.)
 - (1) Open main landing gear wheel well doors and place door ground release handle in down and latched position.
 - (2) Install main landing gear door down locks.
 - (3) Discharge high pressure air from starter air bottle by removing cap from starter air bottle ground charging valve and slowly turning hex nut counterclockwise.
 - (4) Remove gage by first loosening nut on backside of gage attaching bracket and then rotating gage counterclockwise to remove from fitting. Save nut or screw it on elbow fitting for reuse during installation.
- C. Install Starter Air Bottle Pressure Gage (See figure 201.)
 - (1) Install nut on elbow fitting and thread nut past the recess in fitting.
 - (2) Insert fitting into hole in attaching bracket and work back-up ring and 0-ring into recess of elbow fitting.

CAUTION: BE CAREFUL NOT TO DAMAGE O-RING ON FITTING THREADS.





- (3) Thread gage boss onto elbow fitting until gage boss just passes recess in elbow fitting. Make sure gage is in the upright reading position.
- (4) Hold gage from turning and turn nut until a sudden increase in torque is felt indicating contact of O-ring with gage boss. Turn nut down tightly against gage attaching bracket. This holds gage against bracket and seals gage against a pressure leak by forcing O-ring seal into gage boss counterbore.
- (5) Recharge starter air bottle. Refer to Chapter 12, "Air and Nitrogen Servicing."
- (6) Check lines and fittings for leaks under pressure.
- (7) Remove main landing gear door down locks.
- (8) Close main landing gear doors.